SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ON KATHODE RAYS AND SOME RELATED PHENOMENA.**

I.

AMONG the branches of physical investigation that have recently shown especial activity, few occupy a more prominent position at the present time than those that are related to the electrical discharge in rarefied gases. This is true not only because of the rapid development of the subject, but also because of the far reaching importance of the results, and the influence which they seem destined to exert upon widely different branches of physics. When I learned that I was to have the privilege of addressing you to-day, it appeared to me that I could not better utilize the opportunity than by briefly recalling the progress in this subject during the last few years, and calling attention to some of the results that we may reasonably hope for in the future. The whole subject of vacuum tube discharge is, of course, too large to be treated in the brief space of an hour. I shall therefore confine myself to one of its more important subdivisions, namely, the phenomena and theory of the kathode rays.

Of the many beautiful and interesting phenomena that accompany the electrical discharge in rarefied gases, certainly none has attracted such widespread attention as

* Address of the Vice-President and Chairman of Section B (Physics) of the American Association for the Advancement of Science, given at the New York meeting.

the kathode rays. Since their discovery by Plücker in 1859, and the first systematic study of their properties by Hittorf and Crookes, the importance of a more complete understanding of their nature has been generally recognized, and many eminent physicists have made them the subject of extended experimental investigation. In consequence, our knowledge of the kathode rays has progressed during the last few years with startling rapidity. To make clear how great the progress has been, let us consider first the condition of the subject of 1890, at which time the theory of vacuum tube phenomena was just beginning to take systematic and consistent form.

Almost from the time of the first discovery of the kathode rays, widely different opinions had been held regarding their nature. According to one view, the kathode rays were to be regarded as disturbances in the ether, propagated in a manner somewhat analogous to that in which light is transmitted. The rays were not considered as essential to the passage of the current, but as a secondary phenomenon, produced by the discharge. Hertz, for example, suggested that the production of the kathode rays by the discharge in a vacuum tube is analogous to the production of light by the ordinary arc discharge in air. This view furnished a ready explanation of most of the observed phenomena, such, for example, as the rectilinear propagation and diffuse reflection of the kathode rays, and the thermal, mechanical, and luminous effects produced by them. The explanation of the well-known deflection of the rays in passing through a magnetic field was, however, a matter of greater difficulty. I am not aware that a thoroughly satisfactory explanation of this phenomenon, based upon what may be called the ether theory of the kathode rays, has ever been proposed.

The theory proposed by Crookes in 1879, and which usually bears his name, differed radically from that just mentioned. By Crookes and his followers the kathode rays were thought to consist of a stream of negatively electrified particles projected at high velocity from the negative electrode. Such particles would naturally travel in straight lines; upon colliding with solid obstacles their energy would be transformed into that of heat, light, or visible motion; and when moving across the lines of force of a magnetic field they would be deflected from their straight path. The theory of Crookes possessed the great advantage of being concrete and definite, while, at the time the theory was proposed, it was in qualitative agreement with practically all the observed phenomena.

The work of later experimenters, however, had in many instances tended to discredit the theory of Crookes. Thus, the various mechanical effects produced by kathode rays, such as the rotation of radiometer wheels and the like, were found to be due largely, if not wholly, to secondary causes, such as the heat developed by the rays, and the varying static charges on the walls of the tube. Again, if the rays consist of negatively electrified particles, we should expect a conductor placed in their path to acquire a negative charge. Experiments made to test this question were contradictory, but in the majority of cases it was found that the charge was *positive* instead of negative.* Electrified particles moving at right angles to an electrostatic field should be deflected from their straight course; but experiments made by Hertz † and others to detect such an electrostatic deflection gave only negative results. Since the kathode rays are deflected in passing through a magnetic field, we should expect these rays, if they consist of material par-

* Crookes, *Phil. Trans.*, 1879.

† Hertz, *Wied. Ann.*, 19, p. 782, 1883.

ticles, to react upon the field and exert a force tending to move the magnet to which the field is due; no such reaction could be detected.* Many other instances might be cited in which the results of observation were apparently in direct contradiction with the Crookes theory.

Such, in brief, was the condition of the subject at the beginning of the present decade. Of the two theories that had been proposed, each possessed strong arguments in its favor. Neither was free from serious objection.

Previous to this time, very little work of a quantitative nature had been done in connection with the kathode rays, although several estimates had been made of their velocity. Thus, according to Spottiswood and Moulton† the velocity was considerably less than that of light; whole Goldstein‡ had reached the conclusion that the velocity was greater than one four hundredth of the velocity of light. In 1894 a direct determination of the velocity was made by J. J. Thomson§, the method being to observe two fluorescent spots, produced by the kathode rays at different distances from the kathode, by means of a revolving mirror. The result obtained was 2×10^7 cm. per second, or about one thousand times less than the velocity of light. This velocity is practically the same as that which would be acquired by a hydrogen ion repelled from the kathode. Thomson's result therefore supported the view, previously expressed by Schuster, that the kathode rays were not composed of particles of metal torn loose from the electrode, or of charged molecules of the residual gas, but that they consisted of a stream of ions such as occur in ordinary electrolysis.

Recent determinations of the velocity of the kathode rays have shown that the value obtained by Thomson was too small, so that the conclusions based upon it were incorrect. Nevertheless, I am inclined to think that they served a useful purpose. For by directing attention to the discredited emission theory, and to the probable electrolytic nature of gaseous conduction, they stimulated investigation and contributed to the advance of the subject.

The more modern phase of our subject properly begins in 1892, when it was discovered by Hertz* that the kathode rays were able to penetrate thin sheets of gold foil, aluminium, and glass. Taking advantage of this discovery, Lenard in 1893† constructed a vacuum tube containing a small opening covered with aluminium foil, through which the rays passed out into the open air, or into a second tube. It was thus possible to study the rays under conditions which could be readily varied, while the conditions under which the rays were developed remained unaltered. This form of apparatus not only made possible a more systematic study of the known properties of the kathode rays, but also led to the discovery of many new phenomena. Thus, in air at ordinary pressures, the rays were found to discharge electrified bodies, to develop ozone, and to give an impression upon a photographic plate. The photographs published by Lenard, showing the opacity of glass and quartz to these rays, and the comparative transparency of the metals, are strikingly similar to those since obtained with the X-rays. In fact, it now seems probable that X-rays were present to some extent in all Lenard's experiments, and that the phenomena observed by him were in part caused by them.

One of the first questions investigated by Lenard was the influence of the medium through which the rays passed upon their

* Hertz, l. c.

† *Phil. Trans.*, 171, p. 627, 1880.

‡ Goldstein, *Wied. Ann.*, 12, p. 101, 1880.

§ Thomson, *Phil. Mag.*, 38, p. 358, 1894.

* Hertz, *Wied. Ann.*, 45, p. 28, 1892.

† Lenard, *Wied. Ann.*, 51, p. 225, 1894.

intensity and magnetic deflection.* In passing through the air or other gases the rays were observed to suffer diffusion similar to that experienced by light in a turbid medium. It was found that the absorption and diffusion of the rays were approximately proportional to the density. The magnetic deflection, on the other hand, was independent of the medium in which the rays were observed, and remained the same even after the rays had passed through thin sheets of metal.

By changing the conditions under which the rays were generated, different kinds of kathode rays were obtained, whose penetrating power and susceptibility to the action of a magnetic field could be varied through a wide range. Thus, upon reducing the pressure in the tube where the rays were developed, the penetrating power of the rays was found to increase, while at the same time the magnetic deflection became steadily less. In connection with this work Lenard called attention for the first time to the so-called 'magnetic spectrum' of the kathode rays† a phenomenon which was rediscovered by Birkeland‡ in 1896 and has since attracted considerable attention. It appears that a beam of kathode rays is ordinarily not homogeneous, but that it consists of rays which are magnetically deflected in different degrees. In consequence, the fluorescent patch produced by such a beam, after passing through a magnetic field, is no longer sharply defined. In many cases it is drawn out into an interrupted band, in which regions of bright fluorescence alternate with regions of comparative darkness. The resemblance to a banded or bright line spectrum is often quite striking. The phenomenon is now known to be due to the employment of a fluctuating or interrupted current in developing the rays.* Since the character of the kathode rays is so largely dependent upon the conditions under which they are developed, it is natural to expect that when these conditions are unsteady the rays obtained will be non-homogeneous. If the rays are developed by a steady current, the magnetic spectrum is reduced to a single bright line.

* *Wied. Ann.*, 52, p. 23, 1894; 56, p. 255, 1895.

† *Wied. Ann.*, 52, p. 32, 1894.

‡ *Comptes rendus*, 123, p. 492, 1896.

* Strutt, *Phil. Mag.*, 48, p. 478, 1899.

Without stopping to discuss further the interesting and important phenomena investigated by Lenard, let us consider for a moment the bearing of his work upon the two opposing theories of the kathode rays. Upon the assumption that the rays consisted of some sort of wave motion, all Lenard's results were readily explained. That such waves should pass through air, and even through thin layers of metal, was to be expected; the same is true with ordinary light. To explain the diffusion of the rays, it was sufficient to assume that the wave length was small compared with the dimensions of a molecule. The same assumption explained the observed relation between absorption and density. The difficulty in accounting for the magnetic deflection of the rays still remained. But this difficulty was no greater than it had always been, and seemed by no means insurmountable.

On the other hand, to interpret Lenard's results in accordance with the Crookes theory, in the form that it then took, was a matter of great difficulty. That excessively short waves should be able to pass through metal is reasonable enough; but that atoms or molecules should be able to pass is hard to believe. Yet, according to Lenard's experiments, not only must these atoms pass through a grounded sheet of aluminium, carrying with them their electric charge, but they must emerge from the other side with their momentum sensibly unaltered. The suggestion was indeed made by the advocates of the Crookes the-

ory that the rays did not really penetrate Lenard's aluminium window, but that they made of it a secondary kathode, which sent out new rays of its own into the region beyond.* But the objections to this view are numerous. For example, it is remarkable that the secondary rays should be *exactly* similar in their properties to the rays which produced them, regardless of whether the secondary kathode is thick or thin, a conductor such as aluminium, or an insulator such as glass. Again, Lenard obtained these rays both in air at ordinary pressures, and in a vacuum so high that no discharge could be made to pass. In neither case can kathode rays be produced by any other known method. Is it not strange that a secondary kathode, forming part of a grounded metal inclosure, should not only develop these rays under conditions where all other methods fail, but that it should also produce rays of the same kind and intensity under such widely different conditions? These and other objections make it seem highly unlikely that the Lenard rays can be satisfactorily explained by treating the aluminium window as a secondary kathode. In fact, I think that this view has now been very generally abandoned. But even if it were accepted as correct, the difficulties in the way of the Crookes theory still remained. For if the kathode rays consisted of charged atoms, as had been indicated by the work of Schuster and J. J. Thomson, the fact that they were able to pass through air is scarcely less surprising than that they should penetrate thin sheets of metal.†

Lenard himself interpreted his results as offering additional support to the ether theory, and called attention to the fact that in order to explain the observed phenomena the wave-length must be small compared with the dimensions of a molecule. At the close of his first article in 1894 he says, "Judging by the observed behavior of the gases" (viz, diffusion and absorption of the rays) "the ether phenomena that constitute the kathode rays must be of such extraordinary fineness that dimensions as small as those of molecules have to be taken into consideration. Even toward light of the shortest known wave-length, matter acts as though it were continuous. But toward kathode rays, even the elementary gases behave like non-homogeneous media; each individual molecule seems to form an obstacle to their propagation. Analogous phenomena are observed when ordinary light passes through a medium made turbid by suspended particles."

When we consider the condition of the subject at that time, Lenard's conclusion that the rays must consist of something analogous to wave motion seems most natural. From our present standpoint, however, it is seen that his results might be equally well explained by a modification of the Crookes theory. The same difficulties that are surmounted by the assumption of extremely short waves can also be removed by the assumption of extremely small particles. If the kathode ray particles are only small enough, they might pass for a considerable distance through air, or even through metal films; upon colliding with the molecules of a gas they would rebound in all directions, and diffusion would result; and both diffusion and absorption would be roughly proportional to the density of the medium. But this requires that particles of matter should exist which are small as compared with atoms. The suggestion is a startling one, and so violently contradicts our ordinary views of the constitution of matter that it cannot be accepted without strong support. It is not surprising, therefore, that several years

* J. J. Thomson, 'Recent Researches in Electricity and Magnetism,' p. 126. 'Discharge of Electricity through Gases,' p. 190.

† See J. J. Thomson, 'Discharge of Electricity through Gases,' p. 196.

elapsed after the discovery of the Lenard rays before this modification of the Crookes theory was proposed.

In 1895, about a year after the publication of Lenard's results, came the discovery of the X-rays by Röntgen. The widespread interest which this discovery aroused is fresh in the minds of all of us, and is probably without a parallel in the whole history of physics. Apart from their importance from a purely scientific standpoint, and from their sensational features, the X-rays occupy a unique position among the phenomena connected with the electrical discharge in vacuum tubes; for they afford the first instance in which the scientific results obtained in this branch of physics have been made directly useful in everyday life. Although it is not the purpose of the pure scientist to seek directly such applications, yet every instance of this kind is always a source of gratification. Each new case serves to strengthen that belief which forms the real basis of scientific investigation; the belief that every advance in our knowledge of natural law, be it ever so small, or ever so removed in appearance from the affairs of everyday life, must ultimately contribute to the increase of human happiness and the progress of mankind.

The discovery of the X-rays served to stimulate investigation along all related lines. Interest in the phenomena of the electrical discharge through gases, and especially in the kathode rays, became stronger than ever before; for it was natural to expect that the puzzling problem of determining the nature of the Röntgen rays might be simplified by a better understanding of the kathode rays that produced them.

The numerous difficulties and apparent contradictions which had stood in the way of the adoption of the Crookes theory have already been referred to. These may be said to have culminated with the discovery of the Lenard rays, and the theory in its earlier form was of necessity abandoned. But since that time the difficulties have been one by one removed. Thus, in 1896, it was shown by Perrin* that the kathode rays really do carry a negative charge; this conclusion was confirmed by J. J. Thomson† in 1897. That a negative charge is also carried by the Lenard rays was afterwards shown by McClelland,‡ Wien,§ and Lenard.|| By passing the rays through an aluminium window in a completely closed metal box, Lenard was able to give a negative charge to an insulated conductor within. Certainly a more conclusive proof that the kathode rays are electrified can hardly be demanded.

The deflection of the kathode rays in passing through an electrostatic field, which the Crookes theory required, and which Hertz had looked for in vain, was proved to exist by Jaumann ¶ in 1896, and much more conclusively by J. J. Thomson ** in 1897. A year later it was shown by Wien †† and Lenard ‡‡ that a similar electrostatic deflection occurred in the case of the Lenard rays.

Not only were the earlier experiments shown to be in error in both these cases, but the reasons for their failure are now pretty well understood. Probably the most important sources of error were due to the fact that the residual gas in a vacuum tube is rendered conducting by the discharge. The kathode rays also exert a special ionizing influence of their own, so that in those parts of the tube which are traversed by these rays, the gas becomes temporarily a good conductor. In consequence it acts

* Perrin, *Nature*, 53, p. 298, 1896.

† Thomson, *Phil. Mag.*, 44, p. 293, 1897.

‡ McClelland, *Lond. Elect.*, 39, p. 74, 1897.

§ Wien, *Wied. Ann.*, 65, p. 440, 1898.

|| Lenard, *Wied. Ann.*, 64, p. 279, 1898.

¶ Jaumann, *Wiener Berichte*, 105, 2a, p. 291, 1896.

** Thomson, *Phil. Mag.*, 44, p. 293, 1897.

†† Wien, *Wied. Ann.*, 65, p. 440, 1898.

‡‡ Lenard, *Wied. Ann.*, 64, p. 279, 1898.

as a conducting screen, which protects the rays from electrostatic influences. This explanation of the failure to obtain electrostatic deflection was suggested by Schuster* as early as 1890; but the importance of this source of error was not generally appreciated until much later. The fact that a conductor placed in the path of the kathode rays usually takes a positive charge instead of a negative one is doubtless due to the same cause. Being surrounded by a conducting medium, the conductor will receive its charge partly from the kathode rays and partly by induction. The inductive charge will usually be positive, and may be sufficiently strong to determine the sign of the resultant. Doubtless the almost universal employment of the induction coil by the earlier observers was also in part to blame for the contradictory results. The use of a fluctuating current is now seen to introduce many annoying complications. In quantitative work especially, some source of steady current, such as a large Holtz machine or a storage battery, is much to be preferred.

The discovery that the kathode rays carry a negative charge and are subject to electrostatic deflection afforded so strong an argument in favor of the Crookes theory, that attempts were at once made to subject the theory to quantitative tests. The question of the size of the kathode ray particles and the charge carried by them was attacked independently and almost simultaneously by Wiechert† and J. J. Thomson.‡ It is interesting to observe that although the conclusions reached were practically the same, the methods employed were radically different. Wiechert's first

Proc. Roy. Soc., 47, p. 526, 1890.

† Physikal.-ökonom. Gesellschaft in Königsberg. Jan. 7, 1897. *Wiedemann's Beiblätter*, 21, p. 443.

‡ Royal Institution Lecture. April 30, 1897. *Lond. Elect.*, 39, p. 104, 1897. *Phil. Mag.* 44, p. 293, 1897.

determinations were based upon the consideration that since the motion of the kathode ray particle is due to the electrical forces, the kinetic energy acquired by each particle must be equal to the potential energy which it possessed at the surface of the kathode. A relation is thus obtained connecting the charge, mass, and velocity of the particles with the potential of the kathode. A second relation between these same quantities is obtained by measuring the deflection of the rays in a magnetic field of known strength. By elimination it is then possible to determine both the velocity of the rays and the ratio of the charge carried by each particle to its mass. The results indicated a velocity not far from 10^{10} cm. per second, or nearly one-third that of light. That a material particle should move at such an enormous velocity seems almost incredible. It is not surprising that Wiechert felt the need of checking this result by some independent method. He did so by employing a method that had been suggested by Des Coudres* in 1895, and which is independent of any assumption regarding the nature of the kathode rays; the results obtained were of the same order of magnitude as before. That the kathode rays often have a velocity closely approaching that of light has since been abundantly confirmed.

Wiechert's values for the ratio e/m—*i. e.*, the ratio of the charge carried by a kathode rays particle to the mass,—lay between 20×10^6 and 40×10^6 (c. g. s., electro-magnetic units). This is about three thousand times greater than the corresponding ratio for the hydrogen ion in ordinary electrolysis. We must therefore conclude either that the particles carry a much larger charge than is carried by an ion in electrolysis, or else that they are smaller than the hydrogen atom. The latter alternative, which harmonizes so well with the

* *Wiedemann's Beiblätter*, 21, p. 648.

phenomena of the Lenard rays, is the one usually accepted.

The value of e/m was determined by two entirely different methods by J. J. Thomson, the results being published at practically the same time as those of Wiechert. In the first method used by Thomson, the kinetic energy of the particles was determined by measuring the heat developed when the rays fell upon the face of a thermopile, and the charge carried by them was measured by an electrometer. These two measurements, together with the magnetic deflection in a known field, make possible the computation of both e/m and v. The values of e/m obtained in the most reliable experiments by this method ranged from 14×10^6 to 10×10^6. The corresponding values of the velocity were about one-tenth the velocity of light. The second method, which is regarded by Thomson as more reliable, involved the determination of the electrostatic deflection in a known electric field, and the magnetic deflection of the same rays in a known magnetic field. This method gave values of e/m ranging from 9×10^6 to 6.7×10^6, the velocity being about one-tenth that of light, as before. Thomson found that the ration e/m was independent of the nature of the gas in the tube. This result has been confirmed by Kaufmann,* who found that the ration was also independent of the material of the kathode.

The conclusions naturally drawn from these results may be put into the following crude and provisional form: The kathode rays consist of negatively charged particles, or corpuscles, which are much smaller than the atom of hydrogen. These corpuscles are present as a constituent part of the molecule in all substances: whether only one such corpuscle is present for each molecule, possibly revolving about it like a satellite, or whether each molecule consists of an aggregation of corpuscles, it is not yet possible to say. Under the influence of the intense electrical field at the negative terminal of a vacuum tube, the corpuscles are in some cases freed from the forces that hold them to the remainder of the molecule, and shoot off at enormous speed to form the kathode rays.

* *Wied. Ann.*, 61, p. 545, 1897.

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(*To be concluded.*)

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*SOME TWENTIETH CENTURY PROBLEMS.**

It is never a bad plan to improve an anniversary occasion by comparative observations. In commercial and manufacturing lines, short intervals of time are marked by balancing books and checking off accounts, and an inventory is taken at the end of the year without exception. And so it happens that I am going to recognize to-day the fact that we stand at the end of a century, and what I have to say will be influenced to no small extent by the recognition of that fact.

Under ordinary circumstances, with this in mind, I could hardly avoid following the commercial example at the end of the year, and taking an account of stock, balancing accounts, and ascertaining the advance or retrogression in our branch of the scientific world during the period of time that represents three generations of human beings. I do not intend, however, to do this, partly because I do not wish to weary an audience with all that ought to be passed in review in such an important anniversary summation, and partly because, a few years since, Professor H. Marshall Ward, in resuming the botanical progress of the Victorian Era, gave the more important facts, while the vice-presidential addresses of several recent years before this Section have dealt with important advances in botanical thought in

*Address of the Vice-President, Chairman of Section G (Botany) of the American Association for the Advancement of Science, given at the New York meeting.

different directions, and of the progress of the early part of the century Sachs has given a sufficient epitome. I propose, therefore, that we shall consider the inventory and balance sheet as in hand, and that, like the thoughtful business man who has closed his books for the year after noting what he has on hand and what the balance sheet shows, we shall take a general view of the situation, in the hope that some hint of economy or conservatism or changed method may suggest itself as we do so, by which the work of the new century may be furthered.

I have felt some interest in looking over the present trend of botanical thought, as evidenced in a few recent journals and in the advance programs of this Association and the affiliated societies devoted to subjects in which botany figures directly or indirectly. Neglecting strictly economic botany, I observe that taxonomy and descriptive botany lead (42 per cent. in the particular examination made), followed at some distance by morphology and organography (25 per cent.) and physiology and ecology (20 per cent.), while the much smaller remainder (13 per cent.) consists in nearly equal parts of vegetable pathology, phytogeography and floras, and the evolution of plants either in a state of nature or under the hand of man. Though the percentages may vary considerably, the general distribution indicated above would probably apply in the main to the prevalent activity of purely botanical research.

A hasty scrutiny of not far from a thousand periodical publications received at the library of the Missouri Botanical Garden, and all containing at least occasional articles on pure or applied botany, shows, as might be expected, that the percentage of journals restricted to one branch of botany is much smaller than the average percentage contents of the current journals or programs. Even where botany is largely or exclusively represented, the contents of journals are usually very heterogeneous. Notes or longer papers on local floras or on the characters of one or a few species largely preponderate, and there are only a few journals which concern themselves entirely or chiefly with any other single component of botanical knowledge. Among these, vegetable pathology, and economic botany in one or other of its subdivisions, assume a comparable position with morphology and physiology, though, for the reasons stated, all are relatively lowered with reference to taxonomy, as compared with current papers included in the journals. Phytogeography and evolutionary matters appear to be more suitable for books than the other main subjects excepting floras, and they do not appear to have led as yet to the establishment of journals specifically devoted to them.

The preponderance of taxonomic work as indicated by publications calls for a little consideration. Human interest in plants, as in nature generally, appears to have begun in most cases by the observation of useful and injurious or mysterious things; but before the information of the individual could become public knowledge it was necessary to mark differences between things and to name or otherwise designate them intelligibly. It is therefore natural that taxonomy and nomenclature, in one form or other, and however they may have been designated, should have played an equal part with economic observation in even the earlier studies of plants; and it is not at all surprising that the first real science of botany should have been developed along these lines, nor that the awakening interest in other lines of botanical study should have failed as yet to attain an equal position as regards the number of botanists concerned with them.

It is also a very natural thing that the abstract idea of the distinguishable groups

of individuals that have been called species should have been ultimately all but personified, and erected into something supposed to have been realities, divinely established and immutable. Even those of us who have not passed middle age were alive when, as one of my geological friends has expressed it, a Species was treated almost like a thing that had legs and could walk; and even the younger of us have seen the idea grow, from Darwin and Wallace and Huxley and Gray, through the scientific circles into the world at large, that heresy and atheism are not necessarily implied in the belief that existing species are descended from different earlier species, and that their descendants, in all probability, will be considered as yet other species.

If the incident had been closed with a general acceptance of this idea of the mutability of species, we should probably have been spared some trouble which we are now experiencing and which we are actively accumulating for transmission to our followers on the stage; but the change in the theoretical way of viewing the question of species has involved many practical changes in the way of treating them.

In some pliable groups, the expert plant breeder is quite willing to take an order for a non-existent garden form that differs as much from all of the named and classified plants as one species does from another in nature, and, though he may not give a bonded guaranty that it will not revert to some other form after a few years, it is quite likely to transmit its characters for a considerable if indefinite time if bred true, a condition less readily applied in the garden than among species in a state of nature, but scarcely more negligible in the one case than in the other. Whether or not we are to call the most distinct cultivated forms, some of which have been deliberately evolved by the gardener and some of which have originated as sports or sudden variants of either wild or cultivated plants, species, is rather a matter of agreement than anything else, for such as are capable of perpetuation by ordinary natural means constitute, in fact, groups of similar individuals of common origin, reproducing their kind, which is about all that can be said now of natural species.

The growing knowledge of the great and immediate plasticity of species has led to a considerably greater change in the way of viewing them in the abstract than even that which the introduction of evolutionary views caused. That virtually left them as real concepts, though it opened a vaguely distant question as to their beginning and end; but this brings the beginning and end so close together as to cast doubt upon the existence of species at all as definable groups having any considerable stability in time.

I can distinctly recall the thrill of surprise with which, in my student days, I heard of the belief of a distinguished German professor, that species as known in other plants and animals probably did not exist among the bacteria. I felt grateful later that the American flora contains fewer representatives of *Hieracium* than are found in Europe, when I saw the desperate efforts that the Germans have made to distinguish these difficult plants; and the polymorphism of the European brambles made apparent equal reason for thankfulness that American institutions are simpler also in that genus. But the rehabilitation of synonyms and varieties in all groups that the last decade has witnessed, and the increasing rapidity with which the species-splitting knife is falling upon *Antennaria*, *Sisyrinchium*, *Viola*, *Cratægus* and many other genera, have removed any such misguided thankfulness, and the further separability of natural plants, even on the old lines of specific delimitation, appears to be coming into as strong evidence on the one hand as the gardener's power to

create equally distinct species or races is on the other.

There are several ways in which these admissions may affect our judgment and actions. Recognition of measurable parallelism between the operations of nature and of the gardener goes far toward removing a sentimental objection to considering as species the forms which the latter brings into being, but the treatment of both natural and garden forms on a uniform basis is likely to modify the extreme treatment which would otherwise be accorded to either. The garden forms of a given type of plant are often so numerous and so freely subdivisible as to threaten, when this is carried out, either a very undesirable polynomial nomenclature or, what is worse, the multiplication of barely separable genera, in order that the facts may be fully expressed. It is evident that too great a multiplication of genera can but result in unwieldy complexity of system, and it is equally evident that, the ultimate purpose of the systematist being to classify and describe for others the plants which actually exist—whether in the woods or the garden—he must not be content with distinguishing between the more easily separated only, but must provide for all of the forms which either the botanist or the gardener or the user of plants for manufacturing and other purposes needs the means of separating.

We are living through a transition period in our science, and should not close our eyes to the practical meaning of the changes in our beliefs. We are carrying on a movement for so classifying all groups of plants as to indicate their phylogeny by their position—or, otherwise stated, we are continuing the effort of our predecessors to secure a natural system based on real affinity rather than superficial resemblance—and at the same time we are beginning to recognize that the groups of individuals that we call species are of every-day value only in proportion to their simplicity and definability. Two years ago Dr. Farlow made a strong statement of the necessary utilitarian trend of the present attitude with respect to species. My own belief is that this will very shortly become a principal guiding thought in the work of all describers of plants, and that the old idea of something distinct in nature between the concepts of a species and a variety, which has suffered greatly in the changes that have already come about but is still leading to diverse practices, will be eliminated as a factor of any importance.

In the address referred to, Dr. Farlow likened the efforts of the descriptive botanist to those of the happy possessor of a kodak—snap-shotting the ever changing procession of nature. It is evident that if the facts shown have changed before the picture is developed, the latter can be of value for comparison and as a record of change only; but, fully as we may believe now in the changeableness of species, I think that most of us are convinced from our own experience that the span of human life is relatively short enough to prevent discouragement of the best work of which the taxonomist is capable, if, as we are more and more coming to believe necessary, it be conformed to utility as its first purpose—a purpose not at all inconsistent with phylogenetic expression.

One of the questions of daily growing interest and importance is that of the authentication and preservation of type material in descriptive natural history. It is probably and unfortunately true that many more species have been described originally from fragmentary and imperfect material than from adequate specimens, and it sometimes happens that the material of to-day makes possible a very satisfactory synopsis of a genus or family, although the greatest difficulty is encountered in attaching to the different species the names which were

originally given to them. This, of course, is particularly true of groups in which specimens are made with difficulty or are easily destroyed, and, as with Myxomycetes, it sometimes becomes almost or quite impossible to go further back in the application of names than some comparatively recent monographer's collections. A growing disposition is noticeable to subject what may be considered type specimens to more restricted use than was prevalent even a few years ago, and it is easy to see that with the daily increasing minuteness of classification, such preservative restrictions are likely to increase rather than diminish as time goes on. In some of the larger collections, the type material is already being removed from the general collections, and type collections are being formed. I have no doubt that a clear recognition of the meaning and importance of types, cotypes, topotypes, etc., as contrasted with ordinary specimens, will ultimately lead to the general adoption of this practice and to a prohibition of the mutilation of such specimens, even for purposes of minute study, as complete, if not as sensational, as that which the sealing of the cases containing Reichenbach's orchid types for a quarter of a century has effected in that family, possibly to the ultimate benefit of science, but certainly to the impairment of the work of to-day. What are to be regarded as types, cotypes and the like, for species, it is not difficult to see in most cases. A more debatable question, which indeed affects all the groups of plants superior to species, in which are to be expected ultimate upheavals quite as far reaching as those which we see to-day in the lower groups, is that referring to the types of genera and still higher groups. This may form the subject of a committee report at this meeting, and it is to be hoped that conservative and sound but far reaching and uniform action may be secured through the efforts of this committee of the Botanical Club, and of the Section.

In the vice-presidential address before this Section a year ago, Professor Barnes, speaking from the point of view of the physiologist, who often finds plants of very diverse physiological behavior pertaining to one species of the taxonomist, expressed the belief that the plasticity of plants, concerning which much has been learned in recent years, is really so great that it is almost impossible, for physiological purposes, to group together any individuals except those growing under identical conditions; and he hazards the suggestion that the present method of naming plants binomially as species must sooner or later give place to some other and radically different method.

The dependence of the morphologist and physiologist upon the taxonomist is indeed quite as great as that of the student of geographical distribution and the cultivator of plants, and any classification and nomenclature which are to persist as of permanent value must of necessity be alike useful to all who are interested in plants, from whatever point of view. Whatever value the studies of morphologists and physiologists possess to-day comes from co-ordination and generalization in the light of the existing classification of plants, and the future development of these studies is most intimately connected with the evolution of a system of classifying and naming plants which shall at once permit of the ready determination and intelligible designation of any desired group of comparable plants, —a result that alone can avert the very possible danger of a scattering of energy in the accumulation of information concerning untold myriads of individuals, the peculiarities of which, however much they may interest and occupy the student, can scarcely enter into science until co-ordinated and generalized on rational and reasonably permanent lines intelligible to all botanists.

The greater part of the species and varieties that pass the necessarily fine-meshed sieve of to-day are published and defined apart from their nearest relatives, so that their authors are commonly spared the difficulty of really arranging them in the system, and it is doubtful if some species which are now being published would really stand in the minds of their authors were the latter compelled to clearly differentiate them in a comprehensive treatment of the genus to which they belong.

Perhaps the most instructive current effort at a logical co-ordination of the groups of high and low degree is afforded by the Synopsis of the Middle-European Flora now being published by Ascherson & Graebner, who treat the broadly defined groups which Linnæus would have called species as 'collective species,' as subdivisions of which they then recognize species, subspecies, occasionally of several degrees, races, varieties, subvarieties and sports. To subspecies as well as species and collective species they give binomial designations, which unfortunately in a few cases, but not as a rule, are identical. A very good idea of the working of this system may be obtained from their treatment of the *Cystea angustata* of Smith, or the *Andropogon niger* of Kunth.

If the need of subdividing the groups of plants which have heretofore passed as species were no greater for any purposes than for the determination of, for instance, the wild plants of the Middle-European flora, it might not be worth while to follow this subject further or to modify a treatment which gives a possible trinomial for any form which the authors have desired to designate, and in the actual synopsis locates this form in its logical position. Unfortunately, however, unless botany for herborizers is to be a thing quite apart from botany for horticulturists, the general monographer of *Cystopteris*, *Athyrium*, *Andropogon*, *Rubus* or *Pyrus* must soon handle a far greater number of forms and subforms of all degrees than have been attempted even in the most comprehensive schemes yet attempted.

Horticulturists are trying to distinguish between their more transient artificial productions, and natural forms or those which are more closely comparable with such forms. For the former they are trying with more or less consistency and real desire to secure the uniform adoption of simple vernacular names, while for the latter, perhaps with equal consistency and earnestness, they are trying to follow the practice of the botanists, so far as they can ascertain what that is. The actual result of this effort is, for instance, to recognize, in the orchard and the market, a variety of Greening apple known as the Rhode Island, to which each farmer's son and each clerk in the commission house receives personal introduction as he would to a new neighbor or a new customer, and the distinguishing marks of which he familiarizes himself with as he would with those of a man whom he might want to know if he were to see him again.

This is not far different from the way in which men made themselves acquainted with herbs and simples before the day of books. It is very good so far as it goes, but it is neither scientific nor adapted to even the present complexity of that theoretical horticulture which every year is finding greater exemplification in practice. To advance on it, the gardener must fall back on the botanist, whose task will be to systematize what the gardener knows and what his own broader knowledge of plants may add. Now the simple matter becomes complicated. *Pyrus Malus*, for example, represents a species or collective species under which many hybrids and varieties now hopelessly jumbled are capable of arrangement in logical combinations, through which, when they shall have been made, the trained student can run down the Rhode Island or

the Golden Russet with just as great facility and certainty as he can now determine *Ranunculus septentrionalis* or *Trilliam viridiflorum.* For the garden name of the apple, Rhode Island does very well, but for its botanical designation the Latinized name of the last fairly marked form of *Pyrus Malus*, or whatever the species may be called, is wanted. In the case of *Cystopteris* and *Andropogon*, already referred to, this would be given by either the trinomial *Cystopteris fragilis angustata* or *C. eufragilis angustata*, in the one case, and *Andropogon sorghum niger* or *A. eusorghum niger* in the other; but the actual position of either is indicated only by saying *Cystopteris fragilis eufragilis pinnatipartita angustata*, for the one, and *Andropogon sorghum* (sp. coll.) *sorghum eusorghum obovatus niger*, for the other. I fear that the true expression of the facts in many genera, under the present system, would be likely to result either in a polynomial as long as those used before Linnæus' somewhat arbitrary but masterly and helpful simplification of nomenclature, and without the descriptive value of the old phrases, or in the erection of genera nearly on the lines of the Linnæan species.

Either of these results is unpleasant to contemplate, and we may well inquire if they represent the only possible solutions of the problem of even a much finer specific differentiation than is now prevalent. A generation ago the best botanists would not have looked with favor on a proposal to separate species on as fine lines as the more conservative botanists now see to be logical as well as desirable. Perhaps the botanists of to-day may not be prepared for even as radical a change as the separate nomenclature of collective species, species, subspecies, and varieties has already brought to them; but I am not sure that the botanists of the next generation will not carry out a simplification of the present system —which by that time promises to be most unwieldy—that shall be quite as helpful as that which won Linnæus the gratitude of his followers and which we could not do without in the present state of the science.

I have been tempted to enlarge on this point and to exemplify the idea that I have, by a concrete illustration based on some genus of plants in which the number of minute forms to be distinguished is already very large; but I shall content myself by saying that the idea that I have of such a reform is strongly foreshadowed in the practice already introduced of binomially designating collective species and subspecies as well as species; and it goes so far as the employment of binomials down to one remove from the ultimate subdivisions of cultivated plants designated by vernacular names. For many writers on the broader facts of plant distribution and plant properties, the Linnæan conception of species is and will be sufficient, and alone applicable. For such persons, for instance, the name *Cystopteris fragilis* or *Andropogon sorghum* is satisfactory. The necessary degree of subdivision will always vary according to the particular purpose and knowledge of the writer who may care to go further than this. For one, *Cystopteris eufragilis* will be sufficient; for another, *C. pinnatipartita* or an equivalent binomial; for another, *C. angustata;* while still another may find it desirable to specify by not to exceed a trinomial a subdivision of the latter of perhaps three or four degrees removal. The practical result that I foresee, then, is the ultimate uniform establishment of species of several grades, each binomially designated and its grade, perhaps, indicated by typographical means or the employment of a brief symbol connected with the name, unless, after the present nomenclature storm shall have blown by, as it surely will before this point is reached, it be indicated by the adoption of uniform endings for the specific names of each grade.

I can easily fancy a distinct protest at the violence that any such plan will do to our present treatment of species, and a further and greater protest against the possible modification of prior specific names in the interest of uniformity. A contemplation of the results of the current nomenclature reform makes me share in the feeling which could prompt such a protest, yet I venture to believe that the conservatism which opposed and still opposes the relatively trivial priority upheaval that was to have produced a uniformity in plant names that some botanists are still anxiously awaiting, rests upon qualities that are more likely to favor than oppose a far greater and even radical change in the way of naming plants, when such a change shall have become necessary as a matter of practical utility—as it is likely to sooner than most of us suspect.

One of the most serious tasks of the investigator of the twentieth century will be the utilization of the knowledge resulting from the work of his predecessors in the field which he may select for his own activity. The rapid increase in specialization compels him to begin his own productive studies at an advanced point, while the mass of material and the array of facts over and through which he must clamber before reaching his own starting point constitutes a growing handicap, against the beginner and likely often to discourage him and not infrequently to make him a loser from the start in the race for recognition and fame, but in his favor after he shall once have left it to his followers. Very probably, much that he has learned at the start will have to be unlearned later and no doubt might better not have been learned at all, for it is an unpleasant fact that little progress in any direction is made without the aid and embodiment of theories and hypotheses, many of which of necessity are tentative and sooner or later prove to be wrong, and that few wrong hypotheses fail to leave a long persistent trail of erroneous reasoning and even of observation so badly warped as to be absolutely misleading; but aside from what is faulty, there is being brought together daily an overwhelming mass of information of the greatest use, so that everything must be tested step by step as any piece of investigation proceeds, and the faulty detected and rejected, while the trustworthy is built into the foundation on which the author's own conclusions are to rest.

No doubt after assimilating the principal knowledge of the past, every original and really productive worker would feel a sense of relief if he could wipe out the records of this knowledge. Their existence virtually compels him to burden his own discussion of the subject with an analysis, commendatory or critical, of all that has been said of it by his predecessors,—failing in which, he leaves to those who follow him the conclusion either that he has not considered the facts and deductions of earlier students, or that none exist. The presumptive value of his own work must of necessity be greatly weakened if the first opinion is held, and in the other event he is likely to seem to pose as a leader when to the discriminating eye he is merely a follower.

No small part of the difficulty of reaching the point where one's own additions to science begin comes from the fact that the work of those who have gone before him is commonly fragmentary and disjointed. It is a first principle in research that no accurately observed fact is valueless, but its value lies chiefly in its comparability with other facts. As a rule, thought or observation on any subject stimulates the further elaboration of that subject, by drawing attention to minutiæ which any observant person may then note, though he might not have thought of connecting them himself. Science has been both advanced and re-

tarded by the observation and record of isolated facts,—advanced when observation has been followed by further study and the knitting to it of other pertinent observations or when it has proposed a new line of study awaiting a mind great enough to grasp it, but retarded when straws have merely been added to the burden carried by the world of learning.

The botany of antiquity and of the Middle Ages was chiefly a disjointed discussion of plants, largely with reference to their uses, and not a little mixed with mythology and the fables of travelers, whose talents in our time would have proved invaluable to the daily press. Without disparagement to the great men who went before him, Linnæus may be said to have been the first naturalist whose mind grasped numberless details with sufficient precision to really systematize them, just as in our own century Darwin stands far out from his fellows in the same respect, the power to handle and co-ordinate isolated facts which all his work shows being particularly evident in the treatment of the great mass of heterogeneous matter on which were based his generalizations as to the variations of animals and plants under domestication.

Ours has been a century of accumulation and of utilization. It would be unjust to ourselves and our immediate predecessors to say that great laws have not been reasoned out from observed facts in larger measure even than ever before, notwithstanding the advanced point at which science stood when the century opened. It would be also in obvious conflict with the truth to say that the world of manufactures and of commerce has not been most apt to seize upon and employ the more salient discoveries of science, often in a manner not dreamed of by the discoverers; but it may still be said that the century just closing, great as have been its advances, has been a century of accumulation beyond assimilation, a period of roughing out and of laying away lumber far in excess of its employment as joists and sills and boards in the great structure of human progress.

If the evidence of the times may be trusted, the next century is to be marked by a still greater productive activity. Specialization and the attendant division of labor can have no result more logical than this. Though it may suit our convenience to speak of centuries, we know the pure artificiality of such divisions of time, and although still in the nineteenth century, we may with all propriety count ourselves of the twentieth and project the activities and tendencies of to-day into the morrow; but the same drift of the straws which points to a still greater accumulation of minutiæ during the century we are so soon to enter on shows with equal probability that its passage is to be marked by a co-ordination of isolated observations and discoveries far greater than the world has ever before witnessed.

To this very desirable end we of the present day may contribute to no small degree. Our discoveries, as has been said already, are at once the handicap and the foundation stones of the men who are to take our places. The manner in which we leave the records of what we have done decides in large part the preponderance of its utility over its obstructiveness, and in many cases may even determine whether it might not better have been left undone. It is easy to justify ourselves to a certain extent when we do not do the right thing, by pleading that we did not know what the right thing was, because we interested ourselves only in a limited part of what ought to have been handled as a whole, and that posterity ought to be grateful for the substance of our contributions without being too critical as to their form and accessibility; but we are not likely to go far wrong if we assume that few of us who

contribute isolated and disjointed facts and observations will ever be called blessed by coming generations in more than an undertone, that appellation being reserved for those who have builded from as well as hewn out their material, and for those who, even without directly contributing to observed facts, have justly valued the facts ascertained by others and have grouped and shaped and utilized them.

If it could be done within the time that I have proposed to occupy, I should like to consider in detail the entire matter of publication, which is in need of much more thought and concerted action than has yet been bestowed upon it. I fear that the amount of time and thought devoted to the publication of the results of a given piece of research work is often disproportionately small, the fact that they are published at all apparently serving the author's purpose without much regard to the manner in which they are brought out. Publication facilities at one time were few and not readily obtained, but to-day the trouble is rather that they are so numerous and so generally available that even matter unworthy of publication can easily be brought out, and that the authors of meritorious articles are tempted not to look far before publishing their work, but to drop it, hit or miss, into the nearest press, without correlation with other comparable matter or even with the articles to which it stands in juxtaposition, and with too little thought of the convenience of those who are to use it. It sometimes happens, too, that in their zeal they issue simultaneously or otherwise copies of their manuscript to several societies or journals, so that the original place of publication of the article is now and then rendered very questionable.

I should not wish to seem captious in making these statements, for nothing is further from my purpose than destructive criticism; but in view of the growing amount and complexity of scientific publication, I believe that the real needs of the users of botanical literature demand more careful consideration than they have heretofore received, and that this consideration will easily lead to a number of reforms which are perfectly within the power of both author and publisher.

Reference has been made already to the fact that a majority of periodicals are of very mixed contents. So far as societies are concerned, the greater number of these bodies have originated primarily for the development of local interests, and of necessity these interests have been varied. For their own direct purposes, the heterogeneity referred to works very little harm, and for the bibliographer it is the less troublesome because the very condensation of the miscellaneous matter in a local publication places a large part of it where it would naturally be sought. The direct purpose of the publication provisions of nearly all such bodies being not only to secure the permanent recording of observation but to furnish the means of building up a library by way of exchange, it is probable that the partly undesirable mixed contents of the larger number of society publications will continue still for a very long time, but it is encouraging to notice that some of the greater foreign societies have long since differentiated along main lines in their publication, while within recent years a further specialization has been effected in a number of others, notably, for our own country, the California Academy of Sciences, and such differentiation is easily foreseen in others as their membership and activity increase through the formation of sections, each devoted to some particular science, the more strongly represented and active sections being almost certain ultimately to secure the separate publication of their matter.

For the journals which do not emanate from learned bodies, the problem is a simpler one. We already have numerous examples of a primary differentiation into popular and technical journals. The former can hardly fail to be, for the most part, of miscellaneous contents, because they are intended to keep all persons interested in science at large informed on the advances which are being made in its several departments. Familiar illustrations of successful journals of this kind are *Die Natur*, the *Naturwissenschaftliche Rundschau*, *Nature*, *Science Gossip*, *Science*, the *American Naturalist* and the *Popular Science Monthly*, not to mention others of a list which might be greatly extended. Even among these, however, as the examples named may serve to show, there is a considerable specialization on subject lines, and the present issuance of *Science* and the *Popular Science Monthly* under one editorial management may be taken as representative of a process of evolution in active progress, by which even the less technical journals are differentiating into classes adapted to readers engaged in active scientific work and persons having an interest in but not directly engaged with such work.

One further differentiation that is becoming a pressing necessity is that which shall result in a considerable improvement in the specialist's means of keeping himself informed on what has been done in his own specialty. I do not refer to the popular or general presentation of the more striking results of current activity which can be obtained from the general journals or those devoted to each particular branch of science, but to something which of necessity must be limited to that branch and which must be complete. Many of the proceedings of societies and of the journals publish very helpful bibliographies at short intervals, and the *Botanisches Centralblatt* is in large part devoted to this purpose, while the *Jahresbericht*, taking more time than is possible for a current periodical, summarizes and indexes with much greater fullness current botanical literature. Unfortunately, the *Jahresbericht* is so greatly delayed that a period of several years elapses before its pages afford information on any given piece of work, and it is difficult to see how this can be otherwise, in view of the care which is expended in the tabulation and co-ordination of its contents; but without this tabulation and co-ordination, it does not seem to be impossible to secure a very prompt synopsis of all that is issued in botanical literature. The machinery for doing this is already organized in the bureau of the *Centralblatt*, and it is difficult to see why all that is needed cannot be supplied through this channel, if the publishers can be convinced that the botanical public would much rather subscribe for a bibliographic journal, in which all abstracts are of short length and synoptic character, than for one in which many abstracts are entirely disproportionate in length to the importance of the papers they refer to, to the exclusion of others, while the introduction of original matter forces into a supplementary journal no small part of the reviews that are given. Professor Farlow has very well discussed this subject in a recent number of one of the botanical periodicals, and it is hoped that the action initiated at the Naturalists' meeting last winter, which is likely to be brought up by a committee report before this Section, may here find important support, so that either a separation may be secured, of the *Centralblatt* and its *Beihefte* into two journals capable of being subscribed for separately and permitting the desired completeness of bibliography, or other practicable means evolved for attaining this end.

Some years ago, the members of this Association listened with no little interest to Dr. Herbert Haviland Field's explanation of the purposes of his then proposed Con-

cilium Bibliographicum, which has since begun operations in Zürich and I understand is prepared to include botany among the subjects that it handles. It is a matter for regret that the Royal Society's proposal for an international catalogue of current literature has failed to materialize for the time being, but it is possible that if a satisfactory purely botanical bibliographic journal cannot be secured, this scheme can still be put into practical motion. In one way or another, in any event, it is certain that some provision of the kind must be secured within a very few years.

However specialized, publications considered as a whole are in need of far more careful editing than they commonly receive. The author who prepares manuscript for publication is more likely than not to cast it in final form with reference only to what he says in it or what he himself may have already published or may expect to publish at some future time, and the result of this disjointed treatment is perhaps most readily seen when some subsequent compiler, let us say of a popular flora, copies side by side the descriptions of a number of writers. The most diverse phraseology is at once evidenced, although the compiler, on the basis of his own information, may have attempted to simplify the matter somewhat. Comparable things are treated in different paragraphic location; similar facts are stated in dissimilar phraseology; and a character strongly emphasized under one species is not at all considered in another. In one paragraph a certain page of a certain book or journal is cited in one form, and in an adjoining paragraph in another form and perhaps under another author, and possibly even with a different page reference in case, as is often true, author's separates of the article quoted have been issued with individual pagination and even plate numbering.

At the Botanical Congress held in Madison in 1893, this and several other matters calling for uniformity of treatment in the interest of clearness were referred to committees, some of which reported at the next succeeding meeting of this Section or of the Botanical Club of the Association. The increase in intelligibility and simplicity of bibliographic citations noticeable of late years is an encouraging sign that botanists are quite willing to attempt to work out on uniform lines these matters which are of interest to all who have occasion to consult botanical literature, so soon as the method of procedure in each case shall have been carefully codified with reference to the practical difficulties which each writer has to confront.

Among the editorial matters to which really this question of citation pertains, although it practically falls back upon the author, should be mentioned a comparable treatment of comparable facts expressed by diagrams, curves, formulæ, and the like. The tendency of large volume in any publication is to economy of space by the employment of symbols or abbreviations, which must be learned and borne in mind by every reader before the facts which they stand for are intelligible. If these symbols could be standardized for all writers who use this means of expressing their facts, it would result in added value for their work and in a great saving of the users' time. What can be done for symbols, however, cannot always be done for what are treated as abbreviations, because of the fact that the word abbreviated is different in one language from what it is in another; and yet there is no doubt that much improvement can be effected in this direction, while a perfectly uniform result for the entire world may be ultimately attainable by falling back upon the Latin language for words which are to be abbreviated.

Detail matters of this kind are often considered too trivial to occupy the attention

of a body like a section of the American Association, but I am convinced that the numerous discussions which have taken place before the Botanical Club and our own Section have resulted in a much clearer general understanding of the proper meaning of many terms that most of us use almost daily, than would otherwise have been possible, and that each of us has profited to the benefit of his readers by the information elicited by these discussions; and I cannot conceive a more useful way of spending a part of the time of this body each year than in the discussion of subjects of this kind, carefully selected and referred in advance to members or committees capable of discussing them authoritatively from different points of view.

Some of the facts of plant distribution, whether referring to the occurrence of a given genus, species or variety over the earth's surface or at different altitudes, or to the minuter details of distribution demanded for an accurate presentation of some phases of ecology, demand the use of maps, more or less detailed according to the matter to be presented. Nothing is simpler than to so shade or color these maps as to indicate what the author desires to bring out, but, unfortunately, different maps dealing with the same general facts are usually colored very differently. Map evolution consists primarily in the indication of physiographic features, on which political boundaries are more or less artificially superimposed, the representation of geological structure, and the further indication on this foundation of the biological facts which are intended to be shown. The work of the physiographer and geologist is already done to the hand of the botanist, in most cases, and when it is not he is early confronted with the need of supplying deficiencies which exist. It is not many years since the geologists turned their attention to a standardization of their maps which is already simplifying geological literature. Will it not be better for botanists, who already know fairly well the main biological facts that are capable of expression on maps, to confer with the zoologists, who have comparable though different needs of map employment, and with the geologists and topographers, on whose work both can most profitably build, so as to secure an early standardization of method, than to wait until the otherwise necessary confusion due to independent individual practice shall have forced this upon them? I cannot conceive a better outcome of the conference to be held this summer on plant geography than the appointment of a committee to consider this question in detail, not only with reference to their own needs, but to the needs of botanists at large and in consultation with those in other parts of the world who are considering the same problem and the best way of solving it.

If I have confined my remarks thus far to details of internal editing, I should not wish it supposed that other and more general matters do not exist which are worthy of equal thought. No small part of the confusion in citing publications comes from the issuance of the same matter in several different places, either at the same time or at different times, either similarly or differently paged, not infrequently with different titles, and sometimes under a title so phrased as to give no indication of the contents. Books are always likely to undergo revision between different editions and, unfortunately, this is sometimes true of different issues which do not purport to be editions, and an article once published in a journal or book which is not copyrighted becomes by common acceptance the property of the world and may be reprinted legitimately under the author's name, and properly with the further citation of the original place of publication, for an indefinite number of times, during which process

it may undergo considerable modification. It is difficult to see how this can be avoided, and it is difficult to see how reprints can be cited otherwise than with reference to themselves and their original sources, but a great deal of confusion may be avoided if writers who have occasion to refer to reprints (in contrast to separates) will always indicate that they have done so.

We have fortunately in large part passed the age of secondary titles, and it is a matter for congratulation that it is now rarely necessary, when using a new book, to give a secondary or still more subordinate title as a means of specifying the particular work referred to; and the citation of older books makes the occasion for thankfulness that this is so, very evident to all who use the library. In one respect, however, a great improvement is needed. Librarians, who are a very practical set of people whose purpose now is to make any book quickly accessible to anyone who knows either its author, title or subject, have adopted somewhat arbitrary but very serviceable rules for cataloguing and cross-referring, intended to secure this end. With an isolated book comparatively little difficulty is found, but between distinct books, and articles in proceedings or other periodicals, there is an insensible intergradation, owing to the publication of series of various degrees of complexity, which are calculated either for the convenience of a certain class of readers, the glorification of the author or the emolument of the publisher, or are necessitated by the great development of institutional research and publication.

I do not wish to cite examples of terrible things to be avoided, which even a casual inspection of the contents of any large library reveals, but I should not wish to pass the subject by without calling attention to the very great need of editorial reform which devolves upon those who are charged with publishing series, and particularly those whose publication responsibility is so great as to force upon them the unquestionably necessary establishment of such differentiated series. In a late number of the monthly Public Libraries, Mr. Reinick presents a suggestive statement of a librarian's difficulties in the arrangement and cataloguing of the United States Government documents, which is worthy of perusal not only by librarians, but by persons who have occasion to cite such documents and those who are concerned with their publication. Some four years since, Mr. Frank Campbell, of the library of the British Museum, published a series of essays under the collective title 'The Theory of National and International Bibliography,' in which the question here raised is given instructive if perhaps not always final treatment. No one who has occasion either to arrange, catalogue or use the publications of the various branches of the Indian Government or of our own Government, or the publications of our several states, or of the agricultural experiment stations with which each of these states is now provided, or, finally, the contributions which are emanating from the more important research centers, chiefly in the form of separates or reprints of articles originally published in magazines or the proceedings of learned bodies, can fail to see at once the necessity for a collective treatment of all publications organically connected in their origin, and the fact that Mr. Reinick's device of stamps by which the librarian can supply necessary information not printed on the title page is necessitated if the members of a given series are to be unquestionably brought together, carries between the lines a suggestive commentary on the existing facts.

I hope that I have sufficiently brought out my own belief that the writer, the editor and the publisher, who frequently work independently of one another, are in real-

ity tied together by a very close bond, in so far as they are aiming at the real purpose of publication, its usefulness, and that the librarian, the indexer and the reviewer are no less necessary links in the chain between the publishing investigator and his numerous and increasing readers. The practical recognition of this intimate connection is no less necessary for the promotion of the rapid advance of science which the present activity of investigators promises than the unification of the methods of the investigators themselves, and can no doubt be secured in the same manner.

In conclusion, I wish to ask attention for a few minutes to a matter of prime interest to all botanists, since it will probably affect the very prosecution of many of their studies before the next century shall have been closed. I refer to the protection and preservation in every possible way of our native and natural vegetation. To the systematist, the physiologist, and the morphologist, this is alike of importance. Agricultural lands, in the main, of necessity must have their native plants replaced by others if the latter are more valuable to man, as surely as grazing lands have been stocked with cattle after the extermination of the less useful bison. But the erection of an agricultural practice, based on a preliminary clearing of the ground, is quite different from the denudation of the land without further purpose than the utilization of its native products. Primarily the question is an economic one and as such it interests the community at large; but it is also a question of the deepest concern to science. Climatology, the past, present and future geographical distribution of animals and plants, and ecology and evolution are so clearly connected that their devotees possess a common interest in the preservation of natural conditions at least until the factors in biologic nature shall have been directly ascertained and correlated; and I need scarcely add that what has thus far been done in this direction is little more than a rough blocking out for the future. Hence it is that local societies for the protection of animals and plants are worthy of general support in their efforts, and that the widespread forest protection movement, which is too commonly looked upon as simply an economic or sentimental matter, should receive the united encouragement and support of naturalists and meteorologists as a movement the success of which alone can perpetuate for any great time the conditions upon which much of their profounder study is to rest. This Association is to be asked to endorse an effort for the local preservation of the red-woods over a considerable area in central California, and the location of a forest reserve in the southern Appalachians. It is to be hoped that whatever action may be taken shall rest not upon hasty impulse, but upon such recognition of the vast scientific as well as utilitarian importance of this movement as shall ensure the permanence of our interest in every step of the kind which may originate in the future.

William Trelease.
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THE STRUCTURE AND SIGNIFICATION OF CERTAIN BOTANICAL TERMS.

While it is in some sense true that technical names are merely arbitrarily constructed vehicles for conveying ideas on special subjects, in the coining of such terms from the ancient languages for use in scientific description and discussion, it is desirable, at least from an educational point of view, that they should not only be appropriate, but that they should not involve any real etymological error in their construction. From a like point of view it is no less desirable that, when used antithetically, they should be strictly correlative in both con-

struction and signification, as well as relatively constant in each of the three etymological elements which are used in the composition of such terms, namely, the prepositional, verbal and substantival. A considerable number of terms, derived from the Greek, which have come into use in anatomical and physiological botany, while they have been generally accepted and approved, are sadly wanting in some one or more of these requirements. I allude to such terms as heliotropism, geotropism, apogeotropism and diageotropism, which are used with reference to certain plant movements; and to hypocotyl, epicotyl, hyponasty and epinasty, which are used with reference to certain structural conditions.

The terms geotropism and heliotropism, as first proposed by Frank in 1868 and since used by Darwin and botanists generally, are intended to designate respectively the act of the radical portion of plants in turning downward, or toward the earth, and that of the stemmate portion in turning upward, or toward the sun; but in neither case is this accepted signification etymologically the true one. Geotropism being derived from γῆ, the earth, and τρόπος, a turn, or turning, literally signifies earth-turning; and heliotropism, being derived from ἥλιος, the sun, and τρόπος, similarly signifies sun-turning. That is, because they are each composed of verbal and substantival elements only, the prepositional element being omitted, their conventional signification is really far-fetched. Long before either Frank or Darwin used these terms in their present conventional sense, the term heliotrope was used to indicate the habit of the flowering parts of certain plants in facing and following the sun in its daily course. This act being really synheliotropism, or a turning with the sun, is quite different from that which Frank indicated by his special use of the old term. It seems to have been for this reason that Darwin happily proposed in its stead the term apogeotropism, and for the first time introduced the necessary prepositional element in the construction of this class of botanical terms. Strangely, however, although he at the same time also employed that element in the construction of his term diageotropism, he failed to add it to Frank's term geotropism, which should have been written epigeotropism* to make it strictly correlative and antithetic with apogeotropism. These two terms, when made to contain three elements each, are appropriate for the use intended because they signify and fully express the acts of turning toward and from the earth without reference to the sun as the assumed objective point of direction.

Before either Frank's or Darwin's incomparable works containing these and related terms reached America I had, as Professor of 'natural history' at the Iowa State University, constructed and personally used in my lectures the terms epitropism and apotropism in the same manner and for the same purpose that Frank's geotropism and Darwin's apogeotropism are respectively used. These terms I derived from Greek prepositional and verbal elements only, namely ἐπί, toward, ἀπό, from, and τρόπος, a turning omitting the substantival element γῆ, the earth. Because they are thus shorter and more conveniently useable in their adjective and adverbial forms they seem to be preferable to Frank's and Darwin's corresponding terms, even if the former should be amended by adding the prepositional element. While the omission of either the prepositional or verbal element from such terms as these is a real defect, the omission of the substantival element from apotropism and epitropism does not in the least obscure

* While it is true that the radical signification of the Greek preposition ἐπί is upon, it is often, and no less properly, used as equivalent with the English to, or towards.

their meaning because of the special character of the subject in the discussion of which they are employed.

The terms hypocotyl and epicotyl of Darwin, and hyponasty and epinasty of DeVries are objectionable because, being respectively antithetical terms, they are wanting in correlative construction. That is, in their derivation, ἐπί, upon, to, or toward, is made the antithesis of ὑπό, below, or under; whereas ὑπέρ, above, or over is the proper antithesis of ὑπό. Therefore if hypocotyl is used, its antithetic correlative should be hypercotyl; and similarly the correlative of hyponasty should be hypernasty.

Not only are the terms hypocotyl and epicotyl etymologically defective, but their use as originally proposed is not always structurally appropriate. Darwin proposed these terms to indicate the up-growing and down-growing portions respectively of the germinating plantlet, and it is evident from his use of them that he assumed the axis between the opposing portions to be practically identical in position with the points of attachment of the cotyledons. As a matter of fact, however, the cotyledons do not mark any material division in the structure of the plantlet, and the axis referred to is quite independent of their position. In many plants, the bean, for example, the axis is much below the cotyledons and the latter therefore rise above ground as the plantlet grows; while in many other plants, the pea for example, the axis is above the cotyledons, and the latter therefore remain underground. For this inconspicuous, but real, dividing disk between the up-growing and down-growing portions of the plantlet, and also of the mature plant, I have long personally used the term tropaxis, of partially Latinized Greek derivation; and for the parts above and below the axis I have used the adjective terms apotropic, and epitropic respectively.

The terms proposed by Frank, Darwin, DeVries and others have passed into the literature of botany with all their excellencies and imperfections, while my terms apotropism, epitropism and tropaxis have never been published although I have for more than thirty years accustomed myself to their use. I still think they have much merit and therefore offer them for consideration in connection with suggestions for correcting the structure and use of certain terms now generally employed.

CHARLES A. WHITE.

SMITHSONIAN INSTITUTION,
June 25, 1900.

LYMPHOSPORIDIUM TRUTTÆ, NOV. GEN., NOV. SPEC. THE CAUSE OF A RECENT BROOK TROUT EPIDEMIC.

In October, 1899, my attention was called to a disastrous epidemic among the brook trout in a Long Island hatchery. The first evidence of the epidemic was seen in May, 1899, when the director picked out a dead fish from one of the ponds and saw that one side was pierced by a clear-cut hole. Thinking the hole due to some bird like a kingfisher, he threw the fish away without further thought. When, however, he found other dead fish with similar wounds, and when the death-rate became noticeably large, an attempt was made to stop the headway of what was then recognized as a disease. Precautionary measures were useless, and during the summer the fish died off at the rate of hundreds per day. Nor did the disease stop until, in December, every fish in the ponds had died.

Investigation begun in October showed the cause of the trouble to be a hitherto undescribed genus of parasitic Protozoa, which I have named *Lymphosporidium truttæ*, belonging to the same class (Sporozoa) as the malaria germ, although the effects of the parasite on the fish are in no way similar to the effect of the malaria-organism in man. Evidences of the disease in the fish were

shown by the sluggish movements and diminished vitality, while many had clear-cut holes or ulcers, as described above. Others appeared with the eyes entirely gone; in others great patches of skin and underlying muscle tissue had fallen out, leaving large irregular pits in the body walls; others still had lost fins or lower jaws, etc.

Upon working out the life-history of the parasite, it was found that spores accumulate in the lymph spaces of the fish and prevent normal nourishment of the tissues, which die and fall out leaving holes in the body-walls. The spores are taken into the digestive tract of the fish—it is not known from where they came originally; in the intestine they give rise to eight sporozoites or germs each of which develops into an adult amœboid individual not more than .001 inch in length. These adults penetrate the bundles of unstriped muscle cells of the intestine and there become mature. At maturity a spherical spore-forming cyst is formed in the lymph of the fish; here also the spores are liberated, and are then carried to all parts of the body where at different points the accumulations are formed which lead to ulcers.

Two very important points were not determined viz, (1) the origin of the disease which hitherto has probably been unknown, and, (2) the remedy. There was little chance of finding out after October how the disease originated in May, while the extinction of all the diseased fish before the parasite was even discovered effectively headed off experiments with remedial measures. GARY N. CALKINS.

EMBRYOLOGY OF LEPAS. *

THIS paper was based upon the results of an investigation recently completed, which was undertaken with the view of applying the cell-lineage method in an accurate study of the cleavage and the formation of the germ-layers in *Lepas* and other Cirripedes.

The cleavage of *Lepas* is total, unequal, and regular. Stages of 2, 4, 8, 16, 32, and 62 cells are normally formed. Cells of a given generation may anticipate their companions in division, but no second division of such cells takes place before all other cells have completed corresponding cleavages and become of the same generation.

The first cleavage is nearly parallel to the long axis (polar) of the ellipsoidal egg. The egg is divided into an anterior ectoblastic cell and a posterior yolk-bearing macromere. The second cleavage is at right angles to the first, both cells dividing, and from the yolk-macromere is cut off a second ectoblastic cell. The third cleavage is essentially perpendicular to the first two, dividing all the cells, and a third ectoblastic cell is separated from the yolk-macromere, which is now mesentoblastic. Thus by the first, second and third cleavages three protoplasmic cells are separated from the yolk. These three cells contain all the ectoblast and by repeated division they form and extend the blastoderm. The fourth cleavage separates the mesoblast from the entoblast, which is now represented by the yolk-macromere. The 16-cell stage is composed of fourteen ectoblastic cells, which largely surround the entoblastic yolk-cell. The single mesoblast cell lies in the blastoderm at the posterior edge of the blastopore where the entoblastic yolk-cell is still exposed to the exterior. By the fifth cleavage all these cells are divided, the two mesoblastic cells still remaining on the surface. During the sixth cleavage the two mesoblastic cells before dividing sink beneath the blastoderm as it closes over the blastopore. At the same time four cells of the blastoderm, lying at the anterior and lateral edges of the blastopore, divide perpendicularly to

* Abstract of a paper read before the Biological Section of the New York Academy of Sciences, April 9, 1900.

the surface. Four cells are thus formed beneath the blastoderm, and they are apparently added to the mesoblast, for in the next stage their derivatives can not be distinguished from the rest of the mesoblast. The entire mesoblast then originates from one cell which is separated from the entoblast in the fourth cleavage (16-cell stage), and from four other cells which are derived from the ectoblast in the sixth cleavage forming the 62-cell stage. The lineage of these four 'secondary' mesoblasts has been traced back to the first and second ectomeres.

The course of the cleavage as sketched above has been determined to be quite constant. Cells of definite origin in the early cleavage stages are the ancestors of cells which occupy particular positions in later stages. Following Conklin's terminology ('97), the cleavage may be characterized as 'determinate.' This conclusion is completely opposed to the results of the earlier investigators of Cirripede development.

Gastrulation is of the epibolic type, and is the result of the extension of the ectoblastic blastoderm over the entoblastic yolk-macromere. The blastoderm usually closes over the blastopore during the sixth cleavage (62 cells). The blastopore is identified as marking the ventral and posterior of the future embryo.

In the general features of the late development of the embryo the results of this investigation confirm those of some earlier workers.

A paper with figures in support of all the above conclusions has been prepared, and is now awaiting publication.

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ERNST HARTIG.

ERNST HARTIG, 'der Geheime Regierungsrat Professor Dr. Hartig' of the 'kgl. Sächsische Technische Hochschule,' at Dresden, died April 23rd. He was born, Jan. 20, 1836, studied at the Dresden Polytechnikum, finding in the late Geheimrat Professor Dr. A Hulsse an inspiring teacher and a warm friend through whose encouragement and aid he was induced promptly to take up a line of study and work which gave him, ultimately, large opportunities and great reputation. He became, in 1862, the assistant for mechanical technology and was promoted to his professorship in 1865. In 1890 he became the director of the Technical High school. He was active in the organization of the various technical departments and the laboratories of engineering research and made himself an authority relative to the materials of engineering and in all departments of textile work. He published some important papers.

His 'Untersuchen uber die Heizkraft der Steinkohlen Sachsens' came out as early as 1860; from 1864 to 1869 he was engaged in the pursuit of a number of researches and published the results of an experimental investigation of the power required in the operation of spinning and weaving machinery. In 1873 he brought out his work of similar character on the machine-tools and in 1876 that on the machinery of the combed wool manufacture. At the desire of its author, then surrendering his hold upon his long-sustained work in that direction, Hartig undertook the preparation and admirably completed the issue of the fifth edition of Karmarsch's 'Handbuch der mechanischen Technologie' for his old friend and teacher and assumed thenceforth the position of a leading authority in that branch. From 1877 he had much to do with the formulation and systematization of the patent laws and patent systems of the kingdom and of the empire, accomplishing much for the inventor, and for the courts as well. He was an admirer of the United States system and recognized its

enormous influence upon the welfare of the country and in encouraging that fecundity in invention which has always distinguished this country. His spirit, his learning and his logical mind are exhibited in 'Studien in der Praxis des k. Patentamtes,' 1890.

Hartig was named as 'kgl. sächsischen Regierungsrat,' in 1876, and as 'Geheimen Regierungsrat,' in 1888. He was decorated with the 'sächsischen Albrechtsorden Komthur 2 kl.,' and the 'sächsischen Verdienstorden Ritterkreuz I. kl.,' the 'preussische Rote Adlerorden 3 kl.' and the 'österreichische Franz Josef Orden Ritterkreuz' and was made a member of many learned societies.

Ernst Hartig was one of the most modest and companionable of men, kindly, considerate, seeking to please his friends, and always most courteous to strangers. As a colleague on the International Jury of 1873, the writer, working side by side with him for weeks together, came to know the man and to recognize his admirable personal qualities most fully. His affection for his older colleagues and his former teachers, his friends and his pupils was always in evidence. His mind was a storehouse of information and his sincerity and quiet dignity gave him an aspect of age which was yet contra-indicated by his alert and youthful movement. He will always be remembered by those who have known him as one of the most admirable of men, the best of friends and the most able and useful of workers in a field in which there is never likely to be a surplus of such men.

R. H. THURSTON.

SCIENTIFIC BOOKS.

The Grammar of Science. By KARL PEARSON, M.A., F.R.S. Second edition revised and enlarged. London, Adam & Charles Black. 1900. Pp. 548.

It is possible to acquire a speaking and indeed a fairly extensive knowledge of a language without any special attention to its grammatical peculiarities. The conscious realization of syntax and conjugation, or of rules and exceptions may be quite unnecessary in 'picking up' an acquaintance with a new tongue in its local habitat. None the less the student even of 'French at a glance,' or of 'Fourteen weeks in German,' finds it profitable to include genders and declensions, and principles of structure in his aperçu. The more earnest student and, most of all, the specialist must penetrate still more deeply into the intricacies of grammatical structure and development. The same is true, though more readily overlooked in regard to the language of science. In both cases a facility of comprehension and expression, and a sympathy with the pervading spirit or genius of the language are of inestimable value, and for many purposes are indefinitely more useful than knowledge—particularly than unassimilated and uninterpreted book knowledge—of the results of analytical acumen. A scientifically-minded person may be more at home in the realm of scientific fact, may be less likely to wander astray, than he who has greater knowledge of principles with less insight into their practical combination. The observant but empirical linguist may interpret usage with greater success than the formal philologist. None the less the grammatical principles of science are of inestimable importance in imparting breadth and scope as well as depth of insight and vigor of logic to the conceptions of professional scientists and of that larger class who think scientifically and find an interest in scientific problems. That Professor Pearson's 'Grammar of Science' has met the needs of such thinkers creditably and suggestively, is evidenced by the appearance of the second edition, as well as by the comments of approval which greeted the first issue of the volume.

It will hardly be necessary in the notice of this second edition to present an account of the several chapters and of the method of treatment of the book; it will suffice to outline the scope and power of the whole. Three general groups of topics are included. The first portrays the general scope and spirit of science, or describes the purpose of the worker; the second interprets its fundamental conceptions, or de-

scribes the tools of the trade; the third outlines and comments upon the content of the sciences, or describes the materials to be worked upon. Science "claims that the whole range of phenomena, mental as well as physical—the entire universe is its field. It asserts that the scientific method is the sole gateway to the whole region of knowledge." The scientist is characterized by a logical attitude, by a manner of dealing with reality, which when carefully controlled leads to truth, to a common and verifiable possession of mankind. Science discourages short cuts to knowledge and immortality. Science admits and emphasizes its limitations; in an ultimate sense it does not explain but only describes; it has no relations with the supersensuous and is most suspicious of the metaphysical. Science justifies its place in human evolution by the efficient mental training it provides,* by the light it brings to bear on many problems of society;† by its practical benefits in extending control over natural resources and in increasing human comfort; by the permanent gratification it yields to the intellectual and æsthetical impulses.‡

Next we must recognize that all knowledge is a reaction of our mental functions to the stimuli of the environment. There is an essential intervening psychological process between knowledge and reality. We 'construct' our universe, and 'two normal perceptive faculties construct practically the same universe,' and thus render the results of thinking valid. A law of nature is "a *résumé* in mental shorthand, which replaces for us a lengthy description of the sequences among our sense-impressions. Law in the scientific sense * * * owes its existence to the creative power of his [man's] intellect." "It economizes thought by stating in conceptual shorthand that routine of our perceptions which forms for us the universe of gravitating matter." With a just comprehension of the fact that conceptual results form an essential portion of the equipment of science, which is by no means limited to perceptual sense-experience, we may proceed to develop the most profitable conceptions of those general relations underlying the problems of the special sciences. What are cause and effect, and probability? What is the scientific interpretation of space and time, of motion and matter and of their combinations in the physical and organic worlds? With these tools well sharpened and adjusted to their materials the scientific artisans may be sent to their several workshops to work with what success they can command; they devote themselves to physics and chemistry and mechanics; and they find the most distinctly different material in the realm of biology and in the several phenomena of life and evolution. And it is because the sciences are not ready-made material but represent the variety of human interest and the conceptual reactions to perceptual experience that their attempted classification has yielded so diverse and on the whole so unsatisfactory results.

Such, in brief, is the progress of thought in Professor Pearson's 'Grammar.' Many will differ with him in one and another of his positions. The metaphysician will be quick to point out that Professor Pearson's horror of metaphysics is itself the product of a metaphysical assumption; and if the more easy-going scientist expresses his belief that all these matters, like æsthetic judgments, are matters of taste, the logical reply is not far to seek. They are matters of taste, of good taste and bad taste; of sound and critical analysis or of slipshod and loose assumptions. "To know requires exertion, and it is intellectually easiest

* "It is the want of impersonal judgment, of scientific method, and of accurate insight into facts, a want largely due to a non-scientific training, which renders clear thinking so rare, and random and irresponsible judgment so common in the mass of our citizens to-day." "Scientific thought is not an accompaniment or condition of human progress, but human progress itself." (Clifford.)

† "Strange as it may seem, the laboratory experiments of a biologist may have greater weight than all the theories of the state from Plato to Hegel!" "The first demand of the state upon the individual is not for self-sacrifice, but for self-development." "The formation of a moral judgment * * * depends in the first place on knowledge and method."

‡ "If I were compelled to name the Englishmen who during our generation have had the widest imaginations and exercised them most beneficially, I think I should put the novelists and poets on one side and say Michael Faraday and Charles Darwin."

to shirk effort altogether by accepting phrases which cloak the unknown in the undefinable.'' Others again may object to the particular make-up of this 'Grammar'; may question whether the long discussion of the quantitative aspects of evolution (a novel feature of the second edition) however interesting in itself, finds a co-ordinate place with the rest of the chapters, or whether it represents unduly the special trend of the writer's interests. But no critic can fail to find the general treatment rigorous and suggestive, and to feel that the possibilities of presenting the fundamental conceptions of science to the student have been appreciably increased by Professor Pearson's labors in his behalf. JOSEPH JASTROW.

The Microscopy of Drinking Water. By GEORGE CHANDLER WHIPPLE. New York, John Wiley & Sons. 1899. Pp. xii + 300. With 21 figures and 19 half-tone plates.

The biological examination of potable water has been conducted upon an extensive scale in this country for more than a decade, especially in Massachusetts where the State Board of Health and the City of Boston have maintained laboratories for the scientific investigation of water supplies. It is fitting, therefore, that the first extensive hand-book upon the subject of the microscopy of drinking water should have been written by one long associated with this work.

Mr. Whipple's 'Microscopy of Drinking Water,' is more, however, than a mere manual, for it presents the generalization derived from the explorations and statistical data accumulated by the State Board of Health, the Boston, and more recently the Brooklyn Water Works for a series of years. It thus treats of many problems of limnology and fresh water biology of interest not only to the sanitary engineer and water expert but to the biologist and physicist as well.

The opening chapter is devoted to a historical treatment of the subject in which the faunistic and systematic biology of fresh water, and planktology also, are included. The treatment is brief and there are many omissions. There is, for example, no mention of recent investigations of water supplies in European cities, nor is any reference made to the lacustrine explorations of the United States Fish Commission in past years. The excellent work of the Bohemian Survey and of the Balaton Lake Commission in Hungary is unnoticed. Hensen, the father of planktology, is referred to as having devised a 'new method of studying the minute floating organisms found in *lakes!*' The planktonocrit is ascribed to Dolley, and the Plankton pump to Ward and Fordyce. The first use of the centrifuge in plankton work seems to have been made by Krämer or Cori, and the pump for the collection of plankton was used by Henson, by Peck, at the Illinois Biological Station, and by Frenzel, before the pump named was described.

Bacterial examination is not treated in the work as its methods are different and involve other processes than microscopical examination. The purpose and relative values of the various forms of sanitary examination are discussed at length by the author. The physical, biological and chemical analysis of water supplies are each important, and are mutually supplementary. The interpretation of an analysis is a matter of expert skill quite as much as the making of the analysis. "In the detection of pollution the chemical and bacteriological examinations furnish the most information, in the study of the æsthetic qualities of a water the physical and microscopical examinations are most important, while in investigations concerning the value of a water for industrial purposes the physical and chemical examinations sometimes suffice." The purposes of microscopical examination are stated to be the detection of sewage pollution, the explanation of turbidity, of taste and of odor of water, the interpretation of chemical analysis, and the study of food of fishes and other aquatic animals. The most important service which the microscopical examination of potable water renders is thus in the study of its æsthetic qualities.

The Sedgwick-Rafter method of water examination is described with its various modifications and improvements, and the errors incident to its use are discussed. The error from leakage through the sand may rise as high as 25 per cent. or even 50 per cent. when minute organisms are present in large numbers, and the statement is made that most of the escaping organisms pass through the sand in the

earlier part of the filtration. In the reviewer's hands this method has yielded even larger errors with water heavily charged with minute flagellates and other motile organisms, when checked by more precise methods of filtration. The greatest escape of organisms occurred, not at the beginning, but toward the close of the period of filtration. The author concludes that the method is precise within 10 per cent., *i. e.*, two examinations of the same sample seldom differ by more than that amount.

A few pages are devoted to a brief discussion of the plankton method in which the Reighard and Birge nets are described though the more generally used Apstein model is not mentioned. The author objects to the standard unit of volume, a cubic meter, adopted by planktologists on the ground that it necessitates the use of large numbers in the case of minute organisms. In plankton work a uniform unit is a necessity and the small unit of the Sedgwick-Rafter method, which he suggests, is equally objectionable, as it would frequently necessitate the employment of fractions or decimals, and could not be readily correlated with most available and generally accepted unit for quantitative work, viz, the cubic meter. The statement that 'many delicate organisms are crushed upon the net' in the collection of plankton and that the pumping method conduces to imperfect filtration are not borne out by the practical experience of the reviewer.

The comparative absence of organisms in rain and ground waters and in filter-galleries is noted, and their relative abundance in surface waters is discussed. The general statement is made that standing water contains more organisms than running water. "Samples from rivers, unless collected near shore, seldom contain many organisms. Organisms found in streams are largely sedentary forms. Their food-supply is brought to them by the water continually passing. In quiet waters there are found free-swimming forms that must go in search of their food." It is undoubtedly true that there is but little plankton in the small and rapidly flowing streams of New England and in like waters elsewhere; but in larger streams there is a true plankton, often abundant, and very largely made up of typical plankton organisms, as has been shown by investigations of the Elbe, the Oder, the Danube, the Nile, the Illinois and the Mississippi Rivers. The current probably bears some inverse ratio to the number of organisms present in a stream, but the fact of its presence does not necessarily preclude the development of an abundant and typical plankton in river waters, provided *time for breeding is afforded.*

Interesting data concerning the physics of lakes and reservoirs, especially in regard to the seasonal overturning of the water and summer stagnation below the thermocline, are to be found in the chapter on limnology. The organisms which occur in water-supplies are listed with reference to the frequency of their occurrence and their obnoxious qualities. In all 186 genera are catalogued of which but 18 are common, and of these at least 10 are troublesome because of their unpleasant effects upon potable waters. The relative frequency of different organisms and the relation of their occurrences to the depth of the pond, to the nature of the bottom, to the color of the water, and to the chemical analysis are discussed in the light of statistics accumulated in the biological examinations of Massachusetts waters. The same data afford a basis for a treatment of the seasonal, horizontal and vertical distribution of organisms in pond and reservoir waters. Technical matters such as the odors of water-supplies, the storage of ground, and of surface-waters, and the growth of organisms in water-pipes receive expert attention.

A considerable part of the work is given up to a descriptive list of the genera of microscopic organisms which will be of great assistance to the amateur or the beginner. Nineteen well-executed half-tone plates will further assist in the identification of the more common organisms. We note the omission of *Pleodorina*, which occasionally becomes a water-pest; that *Spirodela* is figured as *Lemna;* and that *Diaptomus* appears on the plate with the ovisac *dorsal* to the abdomen.

The bibliography at the close of the book seems to be very full in the technical phases of the subject of water supplies. On the biological side it is less satisfactory, the titles by no means representing the best or the latest literature of the subject, a defect easily remedied in a later edition.

The work of Mr. Whipple is an invaluable guide for the microscopical examination of potable water, in comprehensiveness and execution far surpassing all previous manuals of the subject in the English language, or for that matter in any other. It is also of great interest to the biologist, since it summarizes from literature not ordinarily gleaned the contributions of many workers on varions problems of fresh-water ecology. It is to be hoped that this book will serve as a stimulus to all engaged in this field of applied biology to contribute to the solution of the many unsolved problems which their facilities and opportunities peculiarly fit them to attack. CHARLES A. KOFOID.

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Analyse Chimique Qualitative. Par M.-E. POZZI-ESCOT. Paris, Gauthier-Villars.

This little book is instructive and valuable, as the author, instead of following the beaten track of qualitative separations, adopts mainly the methods of M. Ad. Carnot, and of Engel and Silva for metalloids. He gives especial attention to the detection of the rarer elements, utilizing methods of Cleve, of Wyronboff and Verneuil, and others.

Some of the methods of Carnot are rapid and give elegant results; the method of separating cobalt, nickel, iron, zinc, manganese, thallium, indium, and uranium, utilizing hydrogen peroxide may be particularly commended.

EDWARD RENOUF.

DISCUSSION AND CORRESPONDENCE.

DEFORMED STERNA IN THE DOMESTICATED FOWL.

THE fact that the keel of the sternum is frequently crooked in the domestic fowl has long been known to me, but until the publication of several papers either discussing the cause of this deformation, or bringing it forward as an instance of the inheritance of an acquired character, the reason for it had seemed quite evident. Now it may be that this is one of the cases where a thing is not so simple as it appears to be on the surface, but the primary cause for this curvature of the sternal keel has always seemed to me enforced flightlessness and consequent failure of the pectoral muscles to pull the sternum straight, while this may be aggravated by the feeding of corn which forms flesh, but not bone. Another factor would seem to be the effort to breed fowls that shall be heavy in flesh, attempting to increase the size of the pectoral muscles at the very time the sternum is diminishing in size from the disuse of these same muscles. Thus while the sternum as a whole is degenerating a larger keel is needed for the attachment of muscles and under these conditions the only way to obtain more surface is by the curvature of the keel. It has been remarked that thoroughbred fowls are more liable than others to have deformed sternal keels and these it may be noted are the very birds that get the least amount of exercise. The games, and other breeds not raised for flesh usually have straight sterna while the heavy-bodied Asiatics are particularly liable to have crooked sterna and it may be said that the same deformation often occurs among fancy pigeons bred for show and deprived of exercise by being cooped up in lofts.

That a deformation inconstant in direction and far from universal should not be regularly inherited is not surprising; that it is due to resting the breast on the perch, although this may be one of various causes, is doubtful; that cases where the deformation seems to be passed from mother to chick should be regarded as instances of the inheritance of an acquired character is even more to be doubted.

Finally it may be said that this twisting of the sternal keel is much greater in a dried sternum than in one that is fresh or has been soaked over night in water. Among the sterna of Great Auk collected in 1887 not one was straight, although they could be made straight by soaking and it is a difficult matter to find a straight keel on the dried sternum of a Murre or Razorbill. F. A. LUCAS.

REMARKS ON THE LOESS IN NORTH CHINA.

ALTHOUGH there has been considerable discussion regarding the loess of North China, there are some facts which have not been presented with sufficient prominence, although mentioned by Pumpelly and others. In a trip of 450 miles

from Pekin into Mongolia by way of Kalgan, I observed the following facts:

(1) The loess is a wind deposit without doubt. Along the Tsing-ho, a river joining the Yang-ho near Kalgan, I found that all the north and south tributary valleys had slight deposits of loess in sheltered spots along both sides, and on the south or southeast slopes of the mountains. In the east and west valleys the north side of the valleys, that is the south slope of the mountains exhibited loess hundreds of feet steep, and clinging in sheltered spots to the very summit of the mountains more than 5000 feet above tide.

On the other side of these east and west valleys the loess deposits are practically wanting, except in gullies where there would be a lull in the wind.

The Chinese, who have overrun the Mongolian border, make use of this firm perpendicular cleaving loess for excavating houses which stand well. So the towns are usually found on the south or southeast slope of the mountains, where they have the loess to build in, or to build with, and also the sunny south exposure.

As a rule, depending on the local physical structure of the country, these deposits are rather more on the southeast than south side. In other words, the prevailing winds, then as now, blew from the northwest, down over the plains of Mongolia, the escarpment of which runs from northeast to southwest.

(2) In the valleys it often shows modification by water action. In the valleys and even half way up the mountains bands of rock fragments usually very angular are of common occurrence. These are of local origin and in all cases could be easily accounted for. They were either talus accumulations from the hill back of them, or else were deposited by some temporary stream which was formed by one of the sudden and terrific rains to which this section is subject during the summer months.

In one of the pits northwest of Kalgan there is a U-shaped deposit four feet across, of well-rounded gravel, some of the pebbles being three inches in diameter. It looks as if a stream of considerable size and superloaded with gravel from the hills near by had run over the loess at this point for a short time during the latter's period of deposition.

Lower down in the valley of the Yang-ho, 100 or 200 feet above the present river, especially where side streams have built up deltas at the point of emergence from the mountain passes into the valley, beds of sand, gravel and loess are interstratified. Probably this loess is material brought down either by the main river when it was at a higher level or by the side stream and deposited in slack water.

(3) There was some special period of rapid deposition, and that in quite recent time. Now this loess is everywhere deeply channeled by the little streams that are cutting it away. A very characteristic channel is one 20 to 30 feet, deep, 3 feet wide at the base, and from two to three times as wide at the top. Such miniature canyons will often be cut back a few hundred yards from the valley. Evidently this loess was deposited very rapidly at one time and then for some reason, probably lack of material, ceased to accumulate.

At present there is enough wind to do the work if it had the material at hand. Having been for seven hours in a dust and sand storm between Hsiian-Hua-Fu and Kalgan, I feel certain that the present wind forces are sufficient to deposit loess much more rapidly than it would erode away, provided it had the material. As it is the wind deposits now forming are entirely different from the loess. The drifts are in the same sort of places, but instead of being an impalpable dust are sand. At Hsiian-Hua-Fu the city wall is banked to the very top with drifts of sand, but no loess.

At some recent time the winds must have had an excessive amount of this peculiar fine dust at its command, and the dust must have come from the plains of Mongolia. Whether this material was supplied by glacial grist, furnished by glaciers coming down on to the Mongolian plains from the elevated mountain region to the northeast, or not, remains to be seen. One thing is certain. The glaciers never extended down to the edge of the Mongolian plateau in this region (Lat. 40° North).

(4) This deposit is very recent, for many of the smaller streams have not yet cut their way through it to the rock. This is in marked

contrast to the broad deep valleys in which the loess was deposited—valleys 3000 feet deep and 2 to 7 miles wide.

FRED. B. WRIGHT.

TIENTSIN, NORTH CHINA, May 30, 1900.

POWER OF THE EYE.

TO THE EDITOR OF SCIENCE: We often hear people say that they can merely by a steady gaze affect a person at a distance who is not looking at them; and some say that they are able to make one sitting in front turn the head in this way. Mr. Bell in his 'Tangweera' (p. 198) mentions this feeling when he says: "Presently I felt as if someone was looking at me, and, raising my head, saw a large puma standing ten yards off." To the physiologist it may seem uncalled for to investigate a manifest absurdity, but it has at least a practical value to explode a common error by direct experiment. I asked a young man, who is very confident of his powers, to stand, unknown to re-agent A, behind a book case, and look through a carefully concealed peep hole. I gave him the best opportunity, placing A about four feet from the hole and directly facing him, and I engaged A in mechanical writing. To the young man's confessed disgust and irritation he was unable to disturb A. My few experiments were negative in results. However, it may be that telepathic influence is exerted under certain conditions, and experiments with twins and others constantly *en rapport*, especially when under emotional stress and at critical junctures, might be worth trying. If there be nervous telepathy, this is, perhaps, as simple and common a form as any. If disturbance arose subconsciously the test would be that the tracings from an instrument to show nervous conditions should show large fluctuations coincidently with the times when the agent regards himself as successful.

HIRAM M. STANLEY.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIÈRES OR FREEZING CAVERNS.

A HANDSOME volume under the above title by E. S. Balch has just appeared (Allen, Lane and Scott, Phila., 1900, 337 pages, many illustrations). Nearly a third of the book is given to a narrative of personal experiences in visiting 'ice caves' or freezing caverns in various parts of the world. Fifty pages follow on the causes of subterranean ice; the first suggested and simplest explanation, the cold of winter, being held sufficient against a variety of legendary and fanciful processes. The prevalent belief that freezing caves are colder in summer than in winter and that ice forms in the warm season is controverted by direct observation. The reason for this curious perversion of fact is probably to be found in the temperature contrasts between cavern and external air in summer and winter; the cavern air feeling colder than the open air in summer and warmer in winter. Thermometric records show, however, that cavern temperature is relatively constant all the year round. The whole story is that cold air enters from the outside in winter time and produces ice when there is water to freeze. This simple explanation is confirmed by the occurrence of glacières only in regions where the winter has temperatures below freezing. A compendious list of glacières occupies 100 pages; abstracts of many opinions concerning them, 40 more; and a good bibliography and index close the volume. The views of the ice stalagmites in the glacière de Chaux-les-Passavant in the French Jura are excellent, and the book as a whole is highly creditable to American geographical scholarship.

THE OLD MOUNTAINS OF MICHIGAN.

MONOGRAPH XXXVI, U. S. Geological Survey, by several authors, treating of the Crystal Falls iron bearing district of the upper peninsula of Michigan, contains an instructive account of physiographic features amid a great body of geologic and economic details. The items here abstracted are from chapters by Smyth and Clements. Although the district is partly underlaid by resistant and deformed pre-Cambrian rocks of diverse structures, and partly by weak and gently inclined upper Cambrian sandstones, the most general aspect of its surface is that of a somewhat rolling plain with a gentle and uniform descent for about thirty miles from an altitude of 1800–1900 feet in the northwest to 1200-1300 in the southeast. The areas of harder rocks form broad swells of moderate relief, but

there are no commanding eminences; the widest panoramas from the hill tops extend but a few miles, and the general evenness of the skyline is usually broken only by remnants of the old forest, not yet cut or burnt. It is significant that the name 'mountain' has been applied by local surveyors to hillocks only 100 or 200 feet in local relief. The minor features are explained by the scouring action of the ice sheet on this preglacial peneplain. The areas of massive crystalline rocks have a surface mammillated with rocky knobs and pitted with hollows; the first are largely bare, the second are filled to their brim with ponds or quaking bogs. Ledges and scarps are found at the border of the stronger rocks, while the weaker rocks, eroded to a somewhat lower level, are covered with drift plains which are mostly followed by the main streams. The drainage is very immature, varying irregularly from standing water in lakes and sluggish meandering streams in swamps to flowing reaches in graded drift channels and rushing rapids on rocky ledges. The lakes have generally been reduced to a lower level than that of their original shore line; they are often surrounded by muskegs or reduced to 'hay marshes.' Swamps cover a large part of the surface, not only filling many basins and valley floors, but ascending gentle slopes to the spring line on the hillsides; their thick spongy carpet of moss retains sufficient moisture for the growth of cedars and other swamp-loving trees and shrubs.

This district is of interest as a sample of the geographic conditions that prevail over a vast area of the Laurentian highland in northeastern Canada; an ancient mountainous region, reduced to moderate relief before the Cambrian strata were laid upon it, and since then remaining remarkably quiescent while so many changes were going on in other parts of the world.

WATERPOWER IN NORTH CAROLINA.

BULLETIN No. 8 of the North Carolina Geological Survey (Raleigh, 1899) is devoted to an account of the water powers of that State, contributed by several writers. The volume opens with a chapter on the general physiographic features of North Carolina, in which the essential peculiarities of coastal plain, piedmont plateau and mountain belt are well presented by J. A. Holmes. The fourth chapter, by the same author, discusses the geologic distribution of waterpower and refers the rapids and falls of the rivers to their controlling causes. In the mountains, falls are determined by irregular variations in the resistance of the crystalline rocks; here short ungraded rapids frequently alternate with longer graded reaches. The narrows and falls of the Yadkin in the piedmont plateau occur where the river crosses a belt of resistant schist between belts of weaker argillaceous slates. The Roanoke descends 85 feet in nine miles as it passes from the piedmont crystallines to the weak strata of the coastal plain. The Tar has an abrupt fall of 15 feet at Rocky Mount, some 20 miles east of the border of the piedmont area, where the river has cut down through the coastal plain strata upon a reef of schists and resistant granite. The greater number of pages is devoted to details of individual rivers. The volume is well illustrated by half-tone plates.

W. M. DAVIS.

BOTANICAL NOTES.

RECENT BOOKS FOR SECONDARY SCHOOLS.

PROFESSOR BARNES has prepared a little book under the title of 'Outlines of Plant Life,' for use in such secondary schools as cannot give as much time to the subject as is required by his earlier 'Plant Life.' He has omitted much of the minute anatomy 'upon the assumption that no laboratory work with the compound microscope is possible,' an unfortunate assumption in our opinion. However, the author does not reduce his work to this low plane, but freely introduces suggestions for microscopical studies quite at variance with his prefatory statement. The sequence of structural study is from the simple to the complex plants, considerably more than a hundred pages being given to this part of the subject. This is followed by about the same number of pages devoted to physiological studies, and sixty pages of ecological matter. It should be very helpful to teachers.

The same publishers (Holt & Co.) bring out a smaller edition of Professor Atkinson's 'Ele-

mentary Botany.' The author assumes that the compound microscope is available, and proceeds to plan the work accordingly. The sequence here is in our opinion not as philosophical as that in Dr. Barnes's book, beginning with physiology (114 pp.), with structural studies next (164 pp.), followed by ecology (59 pp.). However, the teacher will find much which is helpful in the book, which has the merit of having much original matter in it.

Here perhaps may be noticed Professor W. W. Bailey's booklet 'Botanizing,' intended to be a guide to field collecting and herbarium work. For this it is apparently well fitted. It describes the equipment necessary for the work in the field as well as in the herbarium, and tells just how the work should be done for different groups of plants. It is not a modern book, for the department of botany with which it deals is not modern. When another edition appears it may be well to make it a field manual in a sense broad enough to include ecological work.

A STUDY OF NON-INDIGENOUS PLANTS.

PROFESSOR AND MRS. KELLERMAN, of Ohio, have been studying the non-indigenous flora of that State, publishing their results in the *Journal of the Cincinnati Society of Natural History* for March, 1900. They find that there are known 2060 flowering plants in the present flora of the State, of which 430, or a little more than 21 per cent., are non-indigenous. Of these foreigners 326 came from Europe, 30 from Asia, 2 from Africa, 46 from Southern and Western United States, 21 from tropical or South America, while 5 are of unknown nativity. It will be seen that more than 83 per cent. of these plants came from the Old World. Fifty-five natural families are represented by one or more species, the largest being Compositae (88), Gramineae (46), Druciferae (27), Labiatae (24), Caryophyllaceae (23), Leguminosae (19), Rosaceae (15), Polyponaceae (14), Scrophulariaceae (14), Umbelliferae (12), Boraginaceae (11), Chenopodiaceae (11). While many of these introduced plants are useful, many also are weeds, no less than 49 falling within this category, and of these all but eight come from the Old World. In order to show that by no means all of the weeds are exotic, the authors give a list of 40 troublesome weeds which are natives of Ohio.

NEW SPECIES OF INSECT PARASITES.

DR. ROLAND THAXTER, who is the authority on the group of insect parasites constituting the family Laboulbeniaceae has been able to add very materially to our knowledge of the group by a study of the material derived from an examination of the entomological collections in Paris, London, Oxford, Florence and Washington. He discovered 168 new species, belonging to 22 genera, some of the latter also being new. The genus Laboulbenia is enriched by the addition of 100 species. The new genera are *Monoicomyces*, with four species: *Polyascomyces*, with one species; *Limnaiomyces*, with two species; *Eucorethromyces*, with one species; *Misgomyces*, with two species, and *Euzodiomyces*, with one species. The descriptions of these new genera and species fill two numbers (9 and 21) of the *Proceedings* of the American Academy of Arts and Sciences, Vol. XXXV., issued respectively December, 1899, and April, 1900. Dr. Thaxter makes the welcome announcement that it is his intention to publish as soon as practicable a supplement to his 'Monograph of the Laboulbeniaceae' with figures of all the species.

PHYSIOLOGY OF TOBACCO.

AN interesting paper entitled 'Physiological Studies of Connecticut Leaf Tobacco,' by Dr. Oscar Loew, contains much of importance to the general plant physiologist, as well as to the practical grower of tobacco, as may be seen from the author's 'conclusions' which we quote in full. "Various problems relating to the manufacture of tobacco have been touched upon in this report, some of them within easy reach of solution, others of a very difficult nature. The prevention of fungous attacks in the barn or in the cases, the regulation of the temperature and humidity in the curing process, and the proper control of the sweat are points that can easily be settled. In many cases the replacement of the stalk-curing by the single-leaf curing process may prove a financial success. But there are other problems of a more delicate and difficult nature, as the prevention of the mosaic or calico disease

and the proper composition of the tobacco leaf while ripening. Upon this composition depends the development of a desirable aroma in the sweating process. Climate and weather are here such potent factors that human art can accomplish directly but little. Too cool and rainy weather may favor, for example, the production of fatty matter, which certainly exerts an unfavorable effect upon the aroma in smoking. There may be produced, however, still other products which are unfavorable to the aroma. Too dry weather may also interfere with the proper composition of the ripening tobacco leaves. By crossing and selection, however, varieties of tobacco may possibly be produced that even under favorable climatic conditions will not form much of the compounds which injure the aroma. In regard to the selection of the seed, it may be mentioned that even now some farmers go so far as to import their seed directly from Cuba each year."

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE RECENT SOLAR ECLIPSE.

A JOINT meeting of the Royal Society and the Royal Astronomical Society was held on June 27th to hear preliminary reports from several expeditions that went out to observe the recent eclipse of the sun. Lord Lister, the president of the Royal Society, was in the chair, and with him was Professor G. H. Darwin, president of the Royal Astronomical Society. According to the report in the London *Times*, Mr. Christie, the astronomer royal, first presented an account of the observations made by himself and Mr. Dyson at Ovar, in Portugal. There totality lasted 84½ seconds, and though the sky was rather hazy he secured some good photographs. The plates employed were 15 inches square, and, owing to their size, were rather awkward to handle; hence he was only able to expose five during totality. The exposures ranged from one and one-half to fifteen seconds. The resulting pictures were exhibited. In several of them the prominences and inner structure of the corona were well shown, while in others considerable extensions of the corona were visible. Mr. Christie also showed some of the pictures taken by Mr. Dyson with a double camera; in one of these at least greater coronal extensions could be traced than were visible to the eye. As to the corona, it seemed very distinctly inferior in brightness, structure and rays to the one seen in the Indian eclipse, appearing, indeed, quite a different object.

Sir Norman Lockyer next described the observations made by the Solar Physics Observatory Expedition and the officers and men of H. M. S. Theseus at Santa Pola. This place, which lay very near the central line of the eclipse, was selected because it appeared likely to meet the requirements of a man-of-war, and without the assistance of a man-of-war the manipulation of long focus prismatic cameras in a strange country was impracticable. Two of these instruments were used, one of which was a new one with a Taylor triple lense of 6-in. aperture and 20-ft. focal length. Out of the great wealth of photographs at his command Sir Norman Lockyer only exhibited a few to give a general idea of his results. Four coronographs were employed. The corona appeared to him a repetition of the one seen in 1878 and different from that of 1871; in several respects he obtained confirmation of the differences between the coronas at periods of sunspot *maxima* and *minima*.

Professor Turner spoke of the observations he had made with Mr. H. F. Newall in the grounds of the observatory near Algiers. He himself had undertaken the photographic work, while the spectroscopic fell to his colleague, a joint program of polarization work being also carried out. Professor Turner spoke strongly in favor of the coelostat, which he had employed, as an instrument for eclipse work, and showed several of the photographs he had obtained. From observations on the brightness of the corona he concluded it was many times brighter than the moon—perhaps ten times as bright.

Professor Ralph Copeland described the observations he made on behalf of the joint committee at Santa Pola, endorsing Sir N. Lockyer's remarks as to the advantage of having the aid of a man-of-war. With his small prismatic camera, in which the optical parts were of quartz or Iceland spar, he was in India, working the instrument himself, only able to take

four photographs, and in one of these at least the instrument was shifted. But an able seaman was able this year to get six perfect exposures with it. Professor Copeland also used the big telescope, 40 feet long, which he had employed on other occasions.

Mr. J. Evershed presented a preliminary report on his expedition to the south limit of totality. His reason for choosing a site at the limit of totality was that the flash spectrum was there visible very much longer. Unfortunately, he accepted the guidance of the Nautical Almanac Office, and found himself outside the line of totality—about 200 metres according to his informants, who said a small speck of sunlight was visible all the time. He was successful in obtaining some fine photographs of the flash spectrum.

THE THIRD INTERNATIONAL CONFERENCE ON A CATALOGUE OF SCIENTIFIC LITERATURE.

PROFESSOR HENRY E. ARMSTRONG contributes an article to the current number of *Nature* from which we take the following facts regarding the recent Conference on a catalogue of scientific literature :

In view of the proceedings of the Conference there can be little doubt that the ultimate execution of this important enterprise is now assured.

Every one was of opinion that if a fair beginning can once be made, the importance of the work is so great, it will be of such use to scientific workers at large, that it will rapidly grow in favor and soon secure that wide support which is not yet given to it simply because its character and value are but imperfectly understood. Therefore, all were anxious that a beginning should be made.

It has been estimated that if 300 sets or the equivalent are sold, the expenses of publication will be fully met. As the purchase of more than half this number was guaranteed by France, Germany, Italy, Norway, Switzerland and the United Kingdom, the Conference came to the conclusion that the number likely to be taken by other countries would be such that the subscriptions necessary to cover the cost of the catalogue would be obtained.

The resolution arrived at after this opinion had been formed, "That the catalogue include both an author's and a subject index, according to the schemes of the Provisional International Committee," must, in fact, be read as a resolution to establish the catalogue.

A Provisional International Committee has been appointed which will take the steps now necessary to secure the adhesion and co-operation of countries not yet pledged to support the scheme.

Originally, it was proposed to issue a card as well as a book catalogue, but on account of the great additional expense this would involve, it is resolved to publish the catalogue, for the present, only in the form of annual volumes.

From the outset great stress has been laid on the preparation of subject indexes which go behind the titles of papers and give fairly full information as to the nature of their contents. Both at the first and the second International Conference this view met with the fullest approval. Meanwhile the action of the German government has made it necessary to modify somewhat the original plan. In Germany, a regional bureau will be established, supported by a government subvention, and it is intended that the whole of the German scientific literature shall be catalogued in this office. In such an office it will for the present be impossible to go behind titles; consequently, only the titles of German papers will be quoted in the catalogue. In England the attempt will be made to deal fully with the literature, and the co-operation of authors and editors will be specially invited. A full code of instructions for the use of the regional bureaux is now being prepared under the auspices of the Provisional International Committee.

The catalogue is to be published annually in seventeen distinct volumes. The collection of material is to commence from January 1, 1901. As it will be impossible to print and issue so many volumes at once, it is proposed to publish them in sets of four or five at quarterly intervals. During the first year, parts covering shorter periods will be prepared, so as to make the subsequent regular issue possible of volumes in which the literature published during a previous period of twelve months is cata-

logued. Unfortunately the United States and Russia were not represented at the Conference.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR HENRY F. OSBORN, professor of zoology, at Columbia University, and curator of vertebrate paleontology of the American Museum of Natural History, has been appointed paleontologist in the United States Geological Survey. Professor Osborn's special field of work will be to take charge of the vertebrate paleontology of the Survey, especially with reference to the completion of the monographs for which the illustrations were prepared under the direction of the late Professor O. C. Marsh.

IT is reported by cablegram from London that Professor E. C. Pickering of Harvard University has been in conference with Sir David Gill with a view to a survey of the east coast of Africa, in which it is said American men of science will participate.

THE Society for the Promotion of Engineering Education, on July 5th, elected the following officers for the ensuing year: *President*, Professor C. O. Marvin of the Kansas State University; *Vice-President*, Professor Albert Kingsbury of the Worcester Polytechnic Institute; *Secretary*, Professor H. S. Jacoby of Cornell University; *Treasurer*, Professor C. A. Waldo of Purdue University.

DR. THOMAS H. NORTON, lately professor of chemistry in the University of Cincinnati, who was recently appointed by the President to establish a United States Consulate at Harpoot, Turkey, in Asia, has sailed on the steamship *Archimede*, of the Italian line, for Constantinople.

DR. W. C. STUBBS, director of the Louisiana Experiment Station, has been selected by the Secretary of Agriculture to visit the Hawaiian Islands and report upon the most feasible plan for the establishment of an agricultural experiment station there. Dr. Stubbs will spend the month of August in the Islands investigating the locations best adapted to a station, the lines of work which should be undertaken, and matters relating to the necessary equipment and expense of maintenance.

DR. S. A. KNAPP, of Louisiana has gone to Porto Rico on a similar mission. These preliminary investigations are in accordance with the recent acts of Congress making appropriation for the office of Experiment Stations of the Department of Agriculture, providing for the establishment of agricultural experiment stations in these island possessions.

DR. J. WALTER FEWKES of the Bureau of American Ethnology has returned to Washington after eight months absence in the field devoted to a further study of the Hopi Indians in Arizona.

DR. CLEVELAND ABBE, JR., of Winthrop College, is spending the field season in Western North Carolina and Virginia as special assistant to one of the hydrographic parties of the U. S. Geological Survey. He is engaged in special study of the physiography of this district while also assisting in the hydrographic survey that is being made by the co-operation of the N. C. State Geological Survey and the U. S. Geological Survey.

PROFESSOR JOSIAH ROYCE, of Harvard University, has been invited to give a course of lectures at Dublin University.

PROFESSOR GEORGE LINCOLN GOODALE, of Harvard University, will be absent on leave next year, and Dr. Rodney H. True has been appointed lecturer in botany for the year.

A CONVERSAZIONE was held at the London Medical Graduates' College and Polyclinic on July 4th, when the museum was inaugurated, and Professor Osler, of Baltimore, gave an oration on 'The Teaching of Practical Medicine.'

AT a dinner given on June 24th, in honor of the yellow fever expedition of the Liverpool School of Tropical Medicine, Mr. A. L. Jones subscribed £1000 towards the erection of a hospital for tropical diseases in Liverpool. In addition to smaller gifts, two subscriptions of £500 from Mr. Blaize, of Lagos, and Mr. John Holt, of Liverpool, were announced.

THE annual visitation of the Royal Observatory at Greenwich, which was this year, owing to the solar eclipse, postponed for a month, took place on June 26th. Among those present were Sir David Gill, from the Cape of Good Hope, Sir William Huggins, Sir George Stokes

and Professor George Darwin. The Astronomer Royal exhibited photographs of the corona taken at Ovar, Portugal, compared with those taken in India, under similar conditions, in 1898. Other work reported upon was the observations and photographs taken with the 28-inch refractor and the Thompson equatorial, including observations of Capella, with a view to determining whether it could be observed as a double star.

IT appears from a recent report of the British Museum that the visitors to the natural history collections at South Kensington rose from 419,004 in 1898 to 422,290 in 1899. In 1899 the weekday visitors numbered 366,572 and the Sunday visitors 55,718, as compared with 368,572 and 50,432 in the previous year. The visits paid to the particular departments for the purpose of study fell from 20,177 in 1898 to 19,120 in 1899. The trustees have agreed to co-operate with the Egyptian Government in a survey of the Nile to determine the species of fishes inhabiting the river. A scientific expedition is to be dispatched to Lake Tanganyika. Particulars are given of the expedition to Sokotra undertaken by Mr. Ogilvie-Grant and Dr. H. O. Forbes, and of Dr. J. W. Gregory's exploration of West Indian Islands.

THE Boston Appalachian Mountain Club held its 35th field-meeting from June 30th to July 7th. Professor C. H. Hitchcock, of Dartmouth College, was one of the guides and was the principal speaker at the evening meeting.

THE large flying cage of the New York Zoological Park, built at a cost of $8000, has been completed and numerous birds have been placed in it. It is the largest cage ever constructed, being 150 feet long, 75 feet wide and 55 feet high.

AN institute for the study of oceanography is to be established at Berlin. Among questions proposed for special study is the mixing of the waters of the Baltic and the North Sea in the canal connecting them. The Baltic, owing to the numerous rivers flowing into it, is less salt than ocean water and its fauna becomes modified as it passes along the canal.

THE daily papers report that Baron E. von Toll will head a Russian expedition which is to search the Arctic coast of Europe and Asia for traces of Andrée. It will start from Norway, proceed by way of Nova Zembla, pass the ensuing winter at Cape Chelyuskin, Taimyr Peninsula, and, searching the Siberian coast during the summer of 1901, endeavor to reach Bering Strait. This dangerous passage has not been attempted since its accomplishment by Baron Nordenskjöld in 1871–3. Capt. W. Bode will this summer take a party of Germans to Franz Josef Land and communicate with the Italian expedition under the Duke of Abruzzi. A Swedish and a Russian expedition will operate in Spitzbergen. Three expeditions, one Swedish, under Professor Vatthoff; a Danish one under Professor Amdrup, and an English one, under Capt. Robertson have already started for the east coast of Greenland.

THE University of Pennsylvania has issued a directory of its graduates in engineering which will be sent on application. The graduates number 469, of whom 445 are living. Of these, about seventy-one per cent. are engaged in engineering practice, twelve per cent. lines in related to engineering, thirteen per cent. in other professions and pursuits, and the addresses of the remaining four per cent. are unknown.

THE *British Medical Journal* reports that the German Government proposes to establish special plague laboratories at Freiberg and Heidelberg for the diagnosis of any suspicious cases of the plague that may occur, and for the prosecution of researches as to the cause of the disease.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Captain George S. Towle, U. S. A., Wellesley College receives practically the whole of his estate which is said to amount to about $100,000. The income establishes a fund to assist worthy students.

BY the will of the late Mrs. Rebecca Reyburn of Baltimore, $20,000 is bequeathed to the Catholic University of America.

BEREA COLLEGE has secured subscriptions for $150,000 which makes available Dr. Pearson's gift of $50,000.

A JESUIT priest of Mindanao has presented to the Roman Catholic College, at Georgetown, a

collection of corals said to be of much value. The collection also contains shells, opals, etc.

THE University of Michigan has established two new courses, namely Higher Commercial Education and Public Administration, which will be open to students this fall. The aim of these courses will be to train men and women for the larger commercial, industrial, political and social opportunities which are now offering themselves to the younger generation. These courses are semi-professional in character and, within the limits of sound scholarship, may be arranged with especial reference to the careers that individual students have in view. Instruction will begin with the opening of the University, September 25, 1900. In connection with these courses six non-resident lecturers have been added to the faculty of the University of Michigan. They are: E. D. Jones, Ph.D., assistant professor in the University of Wisconsin, lecturer on Industrial Resources of the United States; O. M. W. Sprague, Ph.D., instructor in Harvard University, lecturer on International Division of Labor; Lyman E. Cooley, C.E., Chicago, lecturer on the Industrial Significance of Deep Waterways; Robert T. Hill, B.S., United States Geological Survey, Washington, D. C., lecturer on the Industrial Significance of the West Indies to the United States; Thomas L. Greene, manager Audit Company of New York, New York City, lecturer on the Function of the Financier in Industrial Organizations, and W. F. Willoughby, Ph.D., Department of Labor, Washington, D. C., lecturer on the Function of Trades-Unions in Industrial Organizations.

AT the commencement exercises of Alma College in Michigan the new Francis Hood Museum of Natural History was dedicated, and it was announced that the geological collection of the late Alexander Winchell had been presented to the college. In connection with the dedication of the museum, Professor Jacob Reighard, of the University of Michigan, gave an address entitled 'Biology and Education.' Dr. A. C. Lane, the State geologist, said, in connection with the presentation of the Winchell collection, that it was one that a university would be glad to possess and that it must be visited by all students of the paleontology of Michigan.

THE new physical laboratory at Owens College, Manchester, was opened on June 29th by Lord Rayleigh. The new laboratory will have a larger floor area than that of any other similar institution in the world, with the exception of the Johns Hopkins and the Strasburg laboratories. The equipment includes the most modern apparatus for use in every branch of science. Research laboratories are an important feature of the new buildings. The electro-technical wing constitutes a John Hopkinson memorial, and on the occasion of the opening ceremonies was formally handed over by the relatives of the late Dr. John Hopkinson. Professor A. Shuster, the director of the new laboratory, will be assisted by Dr. C. H. Lees, and Mr. R. Beatie has been appointed lecturer in electrotechnics.

THE Board of Governors of McGill University has made the following appointments in the faculties of applied science and medicine. Neville N. Evans to be assistant professor of chemistry, Dr. James Henderson to be senior demonstrator in chemistry, Fred. Soddy, B.A., Douglas McIntosh, B.Sc., Ph.D., and Charles F. Lindsay, B.Sc., to be demonstrators in chemistry; Dr. N. D. Gunne to be lecturer in histology, S. B. Allan to be demonstrator in civil engineering, E. Andrews to be demonstrator in mining, P. W. K. Robertson to be Dawson fellow in metallurgy.

AT Baldwin University, Berea, Ohio, E. W. Berger has been re-elected to the chair of natural science.

OLIVER J. LODGE, F.R.S., professor of experimental physics, at University College, Liverpool, has been appointed principal of the newly established university at Birmingham. Professor Lodge, born in 1851, who has held the chair at Liverpool since 1880, is well known for his researches on electric waves and other physical subjects and as a brilliant writer on theoretical physics.

IN the same university Dr. W. D'Este Emery has been appointed lecturer on bacteriology.

MR. L. LEWTON-BRAIN, of St. John's College, and Mr. A. W. Hill, of King's College, Cambridge, have been appointed university demonstrators in botany.

SCIENCE

FRIDAY, JULY 20, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*PRE-CAMBRIAN SEDIMENTS IN THE ADIRONDACKS.**

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Stratigraphical geology had its rise in those old mining regions of Germany, the

* Address of the Vice-President and Chairman of Section E of the American Association for the Advancement of Science, given at the New York meeting, June, 1900.

The field work on which the above paper is based was done under both the U. S. Geological Survey and the New York State Geological Survey. All the data under the authority of the latter and here drawn upon have been printed. For permission to use much unpublished matter belonging to the former acknowledgments are here respectfully made to the Hon. Charles D. Walcott, Director.

Hartz, the Erzgebirge and Thuringia; and speaking as I do, in a lecture room of our oldest American School of Mines, it is a special pleasure to note this connection and to render to the ancient art of mining—the real mother of geological science—her just due. There is no doubt in my mind that the keen observation of miners had convinced them that there was some regular succession in the rocks, long before this principle found accurate, scientific expression in printed form; but, so far as we know, it was first formally stated by Johannes Gottlob Lehmann in connection with some profiles or cross-sections of the Hartz and the Erzgebirge, which he prepared about the middle of the last century. Lehmann, who was a mining official under the Prussian government, had observed that flat and undisturbed beds rested upon earlier tilted beds and upon crystalline rocks, both of which latter he assumed as his original base but with whose relations he did not concern himself. A few years later in Thuringia, George Christian Fuchsel dealt in a tectonic way with the Coal Measures, the Permian and the later systems, but as we all know it was not until the close of the eighteenth century that William Smith made known the use of type fossils in English geology, nor was it until 1808 that Cuvier and Brogniart, working upon the extremely regular deposits of the Paris basin, established for France if not for the world the use of fossils on a large scale. They brought out a definite system, which anticipated by a few years the issue of William Smith's famous map of England.

It was natural that these results should be attained in regions of simple and easily deciphered stratigraphy, and of relatively modern beds. Taught and inspired by this pioneer work, the geologists of the quarter century that followed interpreted the Tertiary and Mesozoic strata, wherever fairly flat and undisturbed. Even the Coal Measures were studied and placed in their true position, but except in New York, where the older series are likewise flat and undisturbed, the lower lying Paleozoic remained a sealed book. It even seemed a rash and foolhardy undertaking when the two English geologists, Sedgwick and Murchison attacked the hills and mountains of Wales and Devonshire some 75 years ago. The structural problems which this region presented were esteemed too complex and too difficult to justify the expenditure of effort upon them. Sedgwick and Murchison, however, found the clues and by careful work finally classified the strata and despite faults, folds and moderate metamorphism, placed them in their true position. These observations opened up for investigation the whole Paleozoic and set the pace as well as laid out the course for stratigraphical geologists until a decade or two since. So much has now been accomplished, however, that even in regions of very violent change, the problems of the Paleozoic may now be considered to be in a high degree solved, and the range of work upon its series and stages has become chiefly faunal and biological.

But the course of geological investigation has tended ever downward to lower and lower horizons. It may be said that in recent years the chief problems of stratigraphic interest have involved that tempting yet elusive series of sediments that lies below the limits of well-preserved and recognizable fossils. The remains and organisms, which are so abundant and useful in the Paleozoic, disappear in the most remarkable way as we go below the Cambrian, and yet there are few geologists who do not confidently believe that in some corner of the world, not yet fully explored, they will be found in satisfactory abundance. Traces are of course already known. Walcott, in the West; Matthew, in the maritime provinces; and Barrois, in Britany,

have met with encouragement, but the great discoveries remain for the future, because as yet the evidence is meagre and amounts to little more than a stimulus for later work.

And yet despite the lack of organisms, the elucidation of the genetic and structural problems supplied by these ancient sediments is of the highest interest and importance. They carry us ever farther and farther back toward the primeval conditions on our planet, and year by year the circle of the recognized Algonkian closes in on the admissible Archean, and year by year the ancient gneissic areas yield up the secrets of their pedigrees.

Not all the sedimentary rocks, once regarded as pre-Cambrian, have proved to be such on investigation. In many localities metamorphic schists, once supposed to be very ancient, have been safely lodged in the Paleozoic fold, but many more remain and there will be no lack of material for the next generation of geologists to work upon. In all the advances, methods of observation and interpretation have been developed, and the results gained in one locality have been of the greatest service in another. In the Highlands of Scotland, under the guidance of Peach and Horne, we have learned the part that overthrust faults may play and have realized the complex, although not quite hopeless, aggregate of tangled strata which may result. In the Lake Superior region, Irving and Van Hise and their co-laborers have developed the methods applicable in a region, folded in a complicated way and more or less metamorphosed, although not faulted. In the Green Mountains, Pumpelly, Dale and others have dealt with folds, metamorphism and faults, all three. In New Jersey, Nason and Wolff have attacked the old gneisses, worse subjects for stratigraphical elucidation than any yet cited, except the Scotch, and Wolff has appealed with much if not conclusive success to inconspicuous, although fairly persistent bands of peculiar rocks to indicate traces of a sedimentary succession. Adams, in the crystalline areas of Quebec and Ontario has dealt with problems more like those which we are to pass in review to-day than are any of the localities mentioned above. They involve the most ancient gneisses, the crystalline limestones, the vast intrusions of plutonic eruptives, and the same dynamic metamorphism ; but there is one important factor in the Canadian area which we probably lack in the Adirondacks, and that is the most ancient gneiss, there called the Ottawa. At least we doubt if its equivalent occurs anywhere south of the international boundary. With the crystalline limestones and their associates in the Grenville and with the Norian intrusives, however, we have much in common.

Outline of the Adirondacks.—The Adirondacks—under which term I include the crystalline rocks of northern New York—cover about 12,500 square miles. In outline the area is somewhat like a circle, that has been flattened on the East along Lake Champlain, and pulled out to a cusp on the West toward the Thousand Islands. The diameter is very nearly 125 miles. The surface consists almost entirely of crystalline rocks, for, although a few outliers of Upper Cambrian and Ordovician beds are known as much as 40 miles from their parent masses, they are an insignificant fraction of the whole. In the area of the crystallines, metamorphosed representatives of both sedimentary and igneous originals are present. All except the small trap dikes have suffered severely from dynamic processes, sometimes to an extraordinary degree, and in instances the sediments are to be hardly if at all recognized as such. Sufficiently numerous examples, however, remain which can with certainty be referred to their originals, and great probability for

the same derivation can be established for others. While deeply buried, the sediments have been invaded by an enormous mass of plutonic eruptives, of whose nature and succession we now have much evidence. So extensively has this been true on the East, that the sediments are broken up into small and often isolated areas, whose relations are difficult to decipher. On the west as shown by C. H. Smyth, Jr., they are more extensive although everywhere pierced by eruptives. After the intrusions dynamic metamorphism of a pronounced type crushed, sheared and mixed them up with the igneous intrusions; upheaval and faulting disguised the relations; and erosion removed or obscured the evidence, so that a problem is afforded, that is much the same as if the Basement Complex of the Marquette region had invaded the Huronian sediments and had split them up into small areas after which faulting had ensued. And yet in the eastern Adirondacks it does not appear that close folding has very largely if at all taken place. On the contrary, despite the dynamic metamorphism, the decipherable dips in the ancient sediments and the contacts between limestones and neighboring gneisses are often flat, and low folds if any seem to be the rule. Nevertheless crushing and granulation are very wide-spread and have often produced mashing in the rocks of all sorts, except the latest trap dikes. The mashing cannot be due to the larger intrusions, because they exhibit it as much as the sediments, and it must have followed their entrance. It preceded the Potsdam and it must have taken place under a considerable load, else there would have been more severe folding. From this brief general statement it will be seen that the problems possess their own individual characters and in a measure seem to differ from those of other regions unless it be Quebec and Ontario.

Recent Geological Work.—I pass over all mention of earlier workers in the region, because their contributions have already been reviewed elsewhere by me, and because they were not serious in a stratigraphical way. Detailed fieldwork has been required and this has only been attempted by C. H. Smyth, Jr., H. P. Cushing, myself and our assistants. Smyth has worked in the western counties; St. Lawrence, Jefferson, Herkimer and western Hamilton. Cushing has studied Clinton and Franklin Counties on the north; and I have been busied with Essex, Warren, Washington, eastern Hamilton, Saratoga and Fulton. We have however kept in close sympathetic touch in all our work. In Cushing's area less of the undoubted sediments occur, as only two small exposures of limestone have thus far been discovered. In Smyth's area the limestones are most extensive and furnish the best large exhibitions, whereas in the region covered by myself, they are most numerous, although of smaller individual extent, but they have associated with them certain other forms of metamorphosed sediments, which are not yet recorded in such large amounts elsewhere, which are of special interest; and which throw light on the nature of the series. Smyth has suggested the name Oswegatchie series for the limestones and their associates on the West, and while the equivalency of the rocks with the previously named Grenville series of Canada seems probable in a general way, we all have agreed to use this term. Any term must however be considered more or less provisional because as will later appear there is a great gap in outcrops between the original exposures of the Oswegatchie, along the river of the same name, and the near neighbors to it, on the one hand, and the next exposures to the southeast on the other.

VARIETIES OF SEDIMENTARY ROCKS.

Before discussing the general distribution

of the exposures, it will be well to give a brief resumé of the kinds of rocks with which we have especially to deal. Right in this particular appears the great difficulty of a metamorphic problem. In sedimentary or unaltered igneous rocks we are never at a loss to understand their nature and method of origin, but in excessively metamorphosed varieties the great difficulties arise in describing these questions at the very outset, and if we were only sure of many of these puzzling gneisses, the battle would be more than half won.

The Limestones.—The most easily recognized is a coarsely crystallized, white limestone and it is at the same time the widest in occurrence and the most significant evidence of the presence of the old sediments. While at times of considerable purity, as at the marble quarries at Gouverneur, it is generally more or less richly impregnated with graphite, apatite, quartz, pyroxene, horneblende, phlogopite, biotite, scapolite, chondrodite, garnet and feldspars. The silicates tend to be aggregated into streaks and bunches, that owe their shape in large part to the shearing and stretching effects of dynamic metamorphism. In the larger bunches, less common minerals, such as titanite, pyrrhotite and tourmaline are met. Most of the minerals cited above are without doubt produced by the regional metamorphism of more or less siliceous limestones. Such are quartz, pyroxene, hornblende, biotite, graphite, apatite and feldspar. But others, such as tourmaline, chondrodite, scapolite, titanite and to some degree apatite are the results of contact metamorphism, as Smyth has so well shown for the west side of the area.

A variation which is met in several localities, appears when the marbles become charged with serpentinous alteration products, from pyroxenic originals? This is true, most prominently, in Moriah township, Essex county; and in Thurman township, Warren county, although the same rock is met in less amount in a number of other places.

Regarding the development of these limestones it may be only said here, that they are beyond question calcareous and magnesian sediments which involved siliceous, ferruginous and aluminous admixtures, in some cases very richly. During metamorphism the latter elements supplied the materials necessary for the production of various silicates. The limestones appear to be less pure and consequently more charged with silicates on the east than on the west, and to present smaller cross-sections, but from this statement we must omit the contact zones of St. Lawrence county. In judging of the impurity of the limestones we must also make exception of the included masses of rocks, composed of silicates, which in the dynamic metamorphism, have been torn off from the wall rocks or from pegmatite or more basic dikes that had penetrated the limestones before the disturbances. I also reserve graphite for special consideration further on. The limestones exhibit many interesting proofs of having yielded to pressure like viscous substance. They have flowed around the harder inclusions and bordering rocks, have moulded themselves into their irregularities, and have behaved in all respects like a plastic material. This property on their part has made the determination of accurate dips and strikes a matter of difficulty and has added to the obscurity of the problem.

The Quartzites.—But little has yet been stated in print regarding the rocks of this type and they are indeed far less abundant than the limestones. In former papers reference has been made to thin sulphur-yellow beds which accompany the limestones near Port Henry. They are friable quartzites and contain much sillimanite, graphite and pyrite. At Hague, a town on

Lake George, and at a point five miles west from the lake shore, the interesting graphite mines have been opened, which show undoubted fragmental sediments. A bed some 6 to 15 feet thick has been faulted once so as to be exposed in two places. It dips to the west at an angle of 10 degrees and contains abundant flakes of graphite, all of which show a rubbed and streaked appearance from much mashing and shearing. The rock contains little else than quartz and graphite and cannot reasonably be interpreted otherwise than as sandstone, which has been richly charged with some carbonaceous matter, either originally organic or subsequently introduced as some hydrocarbon. Walcott has significantly remarked that the openings look exactly like a coal mine in pre-Cambrian strata. Beneath and above the graphitic quartzite is a garnetiferous gneiss, richly charged with sillimanite. Above the upper sillimanite gneiss is still more quartzite and all rest on a granite gneiss. I interpret the succession as one which involved a sandstone, porous enough to admit the carbonaceous matter now represented by the graphite, and interstratified in a somewhat calcareous, sandy shale now changed to the garnetiferous, sillimanite gneiss. Whether the lower granitic gneiss is an intrusive, which has developed these minerals by contact metamorphism or not ; or whether it was the old foundation on which the sediments were laid down is an obscure question, which I am unable at present to positively decide. The minerals involved are produced both by regional and contact metamorphism. At one point near the mines some small amount of limestone has been revealed by an exploring drill hole, at a shallow depth (30 feet) and on the whole I have been more inclined from the evidence in hand to consider the granitic gneiss as the foundation on which the sediments were deposited.

The largest exposure of quartzite yet recorded is in the town of Lewis, about three miles north of Elizabethtown, in Essex county. Ledges occur more or less charged with graphite and so metamorphosed as to resemble vein quartz, but stratigraphically they have a good dip and strike and they run under gneisses of which I shall later speak. The dip of the quartzite is about 10 degrees and the thickness across the stratification is about 100 feet. The general relations leave little doubt that we are dealing with an old sandstone, somewhat bituminous, and now thoroughly recrystallized. All around are great intrusions of gabbros, anorthosites and syenitic eruptives so that the quartzite remains practically as a little island in the midst of an eruptive area.

In a considerable number of other places these quartzites have been noted and as a rule they have shown a pronounced banded, if not bedded, structure and have almost always exhibited graphite. They likewise very commonly contain dark, rounded discs of a mineral that proves when examined in thin section, to be monoclinic pyroxene. It is irregular in outline and pale green in color. The rocks are therefore aggregates of quartz in excess and pyroxene in considerable amount and are to be interpreted as old quartz sandstones, that contained some calcareous and magnesian admixture, which, during metamorphism, yielded the pyroxene. A little iron oxide also entered into the result. In several instances we have found small masses of the quartzites in the anorthosites, forming inclusions which have been torn off during the intrusion of the igneous rock, and which have been surrounded by small zones or reaction rims, due to contact metamorphism.

Minor Associates of the Limestones.—Another peculiar and characteristic rock that is associated with the limestones in many places in minor amounts consists of quartz and milk-white plagioclase, with occasional

titanites scattered through the aggregate. It seems to be a metamorphic product from the transition sediments between the limestones and the associated clastics.

Likewise associated with the limestones in several localities, but more especially at Port Henry and Fort Ann, there are hornblende schists, of dark black color. They are often involved with the former in a most intricate way, running in as tongues and stringers, penetrating as dikes, which may be broken up into several scattered masses, or appearing as single boulder-like inclusions. In all cases where the rocks are prominently developed, there is easily recognized, intrusive gabbro in the vicinity and the burden of probability would seem to favor an igneous origin for them. At the same time calcareous, magnesian shales might be responsible for similar mineral aggregates, when exposed to excessive metamorphism, as Professor Emerson has shown for the Chester region of central Massachusetts, and in localities of compression and mashing they might become involved in a complex way with softer beds such as limestones; but still I think the Adirondack evidence favors irruptive contacts for them and the mashing and involution of dikes.

An almost invariable associate of the limestones, but in comparatively small amount is a rock consisting of a granular aggregate of dark green pyroxene. Some little calcite may often be detected in the interstices between the pyroxene, but as a rule the coarsely crystalline bits of the former make up practically the entire mass. The rock has manifestly resulted from the metamorphism of siliceous transition deposits from the limestones to the clastics.

Garnet Pyroxene Rock.—At two localities, one in Keene valley, on the west bank of the Ausable river and about a mile above Keene Center, and the other in northwestern Lewis, extensive ledges of a peculiar rock have been met that seems to belong to the limestone series. It is quite massive and gives no trace of dip or strike. It is a coarsely crystalline aggregate of deep red garnet, and green monoclinic pyroxene. In each case the ledges are associated with hornblendic gneisses and they may be a peculiarly altered, calcareous sediment, but the mineralogy strongly suggests contact metamorphism upon limestones, although in neither case was it possible to establish the presence of eruptives in the immediate vicinity. In the Keene locality anorthosites are in masses of mountain size, within half a mile, but gneisses intervene. In the latter case no eruptives of the gabbro family are near enough to be reasonably considered causes in the effect.

The Sedimentary Gneisses.—In intimate relations with the limestones in many localities and in quite extended outcrops, without them in other places, are gneissoid rocks that are quite certainly altered sediments. They are characterized by a very pronounced and persistent banding and the banding is regular and runs for very considerable distances. The transitions from dark bands, consisting of prevailing bisilicates to lighter ones containing quartz and feldspar are abrupt and can only be accounted for by changes in sedimentation. They differ entirely from the short lenticles which are produced by the stretching of the minerals of an eruptive rock. The layers are at times quite pure quartz and again suggest the mineralogy of pegmatites. Graphite is a very common mineral and is one of much significance.

On account of fragmentary exposures and the ever present drift or forest growth it is difficult to determine the actual thickness of these rocks. In southwestern Jay township, Essex county, I have paced carefully over a series of continuous exposures of very regular and flat dipping beds that were at least 75 feet thick and then became concealed under drift. A mile

away they again appeared on a mountain side with very nearly the same strike and dip and there is no doubt that a very considerable thickness is present. Gabbros in one direction and anorthosites in another cut them out, and on the strike they were traced into exposures which contained limestones. Graphite was abundant both in limestones and gneisses.

In many other localities these same rocks have been met but mostly as isolated exposures in the midst of the heavy forest growth and too few in number to enable us to work out their thickness or their accurate relationships, but there is no doubt that they represent sediments that must have been originally of the nature of sandy shales, which at times had more richly calcareous layers and which, in this way, yielded the variable metamorphic results, now accessible to us. As a rule the dips of these gneisses are low, although high dips are met.

Besides the gneisses just described, which exhibit the marked regularity in their banding there are others that are more massive and uniform, and yet that from their general relations and associations give strong evidence of belonging in the sedimentary series with the limestones. They are almost always rusty on their outcrops as distinguished from the certain eruptives and whenever this character is observed we commonly look with success for the near presence of limestones. Although apparently quite basic the microscope reveals in most cases quartz and microperthite as the light-colored minerals in the midst of the prevailing hornblende and less augite. Plagioclase is not lacking, but is decidedly subordinate. Graphite has been occasionally detected in them.

These rocks have proved exceedingly puzzling members to deal with in the field, because one would be inclined at first sight and from microscopic examination to regard them as gneissoid gabbros or diorites, but the microscope gives the results just specified and the structural relations which will be shortly taken up lead to the conclusion that they are altered sediments, and that they probably represent large and fairly uniform bodies of shale.

Professor Cushing has noted in the eastern part of Franklin county considerable outcrops of a very coarsely crystalline and slightly rusty rock, which I have likewise had the privilege of studying in the field with him. It consists of almost nothing else than lenticles of quartz, half an inch or more wide, an eighth or more thick, and an inch or two long, which are set in a matrix of microperthite. Practically no dark silicates appear. I have also occasionally observed the same rock further south and I do not know how to account for it otherwise than as a recrystallized and squeezed conglomerate, whose pebbles have been stretched and rolled out to the lenticles and whose interstitial filling has yielded the microperthite. If this view be correct, we have all the ordinary members of a sedimentary series represented among these metamorphic rocks and a much more probable association for an important and extended member of the geological column, than would any one or two of the above cited members be alone. It is quite possible that others of the more massive gneisses are altered sediments rather than sheared eruptives, but in the absence of positive proofs I hesitate to take even a tentative position regarding them, although I am free to admit that beginning with prepossessions in favor of the igneous origin of many of the gneisses, I have become more and more convinced that altered sediments play a very prominent rôle.

GENERAL DISTRIBUTION OF THE METAMORPHOSED SEDIMENTS.

The Northwest. — The crystalline limestones furnish the most widely distributed, indubitable form of pre-Cambrian

sediment with which we can deal in a general sketch, but as already indicated it is fully within the bounds of probability that other kinds of rocks will be recognized to possess this same character, as time goes on and observations accumulate. The limestones are in much the largest amount of all the Adirondack localities in the northwest, where they have been investigated by Professor C. H. Smyth, Jr. St. Lawrence county chiefly contains them and they are also found in important areas in the neighboring counties of Jefferson and Lewis. They are not all accurately mapped as yet. They constitute large northeast and southwest belts as well as minor exposures, but to what extent additional ones are buried beneath the Potsdam, the Drift and the forest growth we have no means of knowing. Smyth has already mentioned four principal belts. The northwestern one is called the Macomb. It extends from Theresa township, in Jefferson county, across the county line and through Rossie, Macomb and De Kalb into De Peyster, St. Lawrence county. This makes a distance of about 25 miles and the belt may be 2 miles across. The next one to the southeast is the Gouverneur belt, the largest of all. It begins in Antwerp, Jefferson county, and runs for 35 miles through Rossie, Gouverneur, and De Kalb, terminating in Canton. It varies from 2 to 6 miles across but is somewhat divided as regards outcrops by overlying Potsdam and by gneiss. The next belt to the southeast runs from Fowler township through Edwards and terminates in Russell; and the last of the four extends from Wilna, Jefferson county, through Diana in the same county, to and into Pitcairn, St. Lawrence county. All lovers of minerals will recognize at once in these names classic localities of many species, which more than any other one product have served to make this region known, the world over.

There are other small areas in Pierrepont, Parishville and Potsdam further north, which have been located by Professor Cushing upon his published map of the boundary of the Potsdam, executed for Professor James Hall, and if we may draw inferences from Professor Ebenezer Emmons' few notes in the early Survey of the Second District of New York, still other outcrops exist toward the Thousand Islands of which Professor Smyth will no doubt prepare descriptions in time. But when one passes to the southeast of the Diana belt, Smyth has stated that for 30 miles the gneisses extend without a break. Limestones are however known at the Fourth lake of the Fulton Chain, as recorded by Vanuxem and they have been found by Smyth in small amount amid gneisses near Bisby lake and on the South Branch of the Moose river at its junction with Limekiln brook. Emmons also mentions limestones as abundant around a lake that he calls Lake Janet and again Lake Genet, and describes as being at the head of the Marion river. Lake Janet is apparently the one now called Blue Mountain lake but although fairly detailed work has been done around it by my assistant D. H. Newland, no record of these rocks was made and there may be some mistake about the earlier note.

Despite these small areas last mentioned there still remains a vast extent of crystallines that form a broad area from northeast to southwest wherein no sediments are known. This is the greatest stretch of the whole Adirondack region that is devoid of them and as it forms a somewhat pronounced belt, parallel to the general structural trend of the country, it cannot well be without some special significance. Much of this stretch in Franklin County has been shown by Cushing to be anorthosite, but to the southwest it appears to be granitic gneiss, of greater uniformity than is usual elsewhere.

The Eastern Side.—Beginning on the north-

east, but one exposure has been met in Clinton County and that is a stratum about 20 feet thick and 150 feet long at the foot of Catamount mountain. Dip and strike are very difficult to determine with accuracy. The bed apparently passes into the mountain at an angle of about 45–60 degrees. The relations will, however, be more fully commented on in taking up the stratigraphical features under a subsequent topic.

Just across the line in Franklin county, and near the village of Franklin Falls, there are two separated ledges of limestone. The dips are low and with the calcareous beds are rusty hornblendic gneisses and some graphitic quartzite, the latter being certainly sedimentary and the former probably the same. Intrusions of anorthosite have served to obscure the larger relations.

In Essex county, to the south, in St. Armand township, a double bed of white, crystalline limestone outcrops at the foot of the steep, westerly spur of Whiteface mountain. It lies embedded in feldspathic gneisses, but anorthosites outcrop further up the slope. In North Elba, the next township eastward, and on the western slopes of Sentinel mountain, in the Wilmington pass, a small ledge of limestone has been met, obscurely exposed in the bed of a little brook. Passing to Keene township, the next one east, there are a number of exposures in the northern portion that together constitute a pronounced belt. From a point a mile south of Keene Center for several miles to the north, until one passes into Jay, they may be located first on the west side of the valley and then on the east. Quartzites in small amount and a great thickness of dark, rusty hornblendic gneisses accompany them. Away from the central valley and well up into the bounding ranges of mountains, limestones have been discovered both in the eastern and southeastern portions of Jay. Over the high divide in Chesterfield township, the next one to Jay on the east, two exposures have been met, each time involved with gneisses, but each time in a region where huge intrusions of anorthosite are likewise serious factors in the geology, although at some distance from the limestone. In Lewis township, next south, as well as in Elizabethtown which lies beyond, a long succession of limestones and quartzites in a general north and south belt, are met over a stretch of at least 15 miles, but they are much broken up by anorthosites and basic gabbros. In two or three instances, however, the ledges are of the greatest stratigraphical interest, as I shall shortly bring out.

In the valley of Lake Champlain a small exposure of limestone with much associated graphite forms the extreme point at the picturesque Split Rock, Essex township, a landmark to all travelers by steamer on the lake. While the amount of limestone is not great, the associated gneisses are in considerable development, before they are replaced by anorthosites, which make up the main part of the Split Rock range. No more limestones are then met until a point is reached in the hills in the extreme southwestern part of Westport, where again a small ledge has been located in the midst of an area consisting chiefly of the plutonic intrusives. In Moriah township, both on the lake near Port Henry and back in the upland valley which rises to the westward from the lake, the limestones are frequent and of considerable thickness. Next the lake they are the best exposed and thickest of any outcrops in the eastern part of the mountains. Details of the exposure have already been printed by me. In Crown Point and Ticonderoga, the next townships south along the lake, small ledges have been located in many places and relatively large areas of the associated gneisses, and if we pass right down into Washington county, on the south, we shall find in the high narrow ridge that lies between Lake Champlain

and Lake George several small beds in Putnam and Dresden townships. In Whitehall and Fort Ann, however, the exposures become more serious and give greater promise of stratigraphical results. At Whitehall an attempt has been made by me to work them out, and in a report, that will shortly appear from the office of the State Geologist in Albany, a detailed map with cross-sections will be given which indicate a marked anticlinal character for them and the associated gneisses. Quartzose gneisses are also present that afford strong evidence of being metamorphosed sediments.

If now we return to the latitude of Crown point and Ticonderoga and pass westward into Schroon, we find a belt along a somewhat marked depression, ranging from western Crown Point, through the valley of Paradox lake to and along Schroon lake. There are likewise scattered outliers in the adjoining hills. Still further westward in Minerva and again to the north in Newcomb, right in the heart of the mountains and west of the highest peaks, very extended outcrops occur, as usual with the associated gneisses. They scarcely cross the line from Essex into Hamilton county to the west, but they run south through Warren county and appear in small and scattered areas in Johnsburgh, Chester, and Thurman. In eastern Hamilton county, two or three have been discovered in Wells and Lake Pleasant townships. But then they seem to end so far as our present information goes, and from these townships southward along the western border line of Hamilton county and in a sweep around to the westward along the southern rim of the crystallines, so far as known they fail. To the eastward in Warren county, we have located a number of small and scattered outcrops, amid the gneisses of Horicon and Bolton townships, while in Hague are the interesting quartzites already referred to. In the several townships that intervene on the south before the mantle of the Paleozoic conceals the crystallines, the limestone is lacking so far as known.

Resumé.—In a brief general survey of these various details, it is evident that the limestones are chiefly found along the northwest and southeast or eastern portion of the great crystalline area. In its northern portion they practically fail, and in the broad band running from northeast to southwest across it, they are unknown. They are likewise absent in the southern and southwestern border. On the northwest they are in extended and comparatively broad belts, but in the eastern portion they appear in many small and separated exposures, associated with some quartzites and much greater amounts of characteristic gneisses, but greatly broken up by igneous intrusions.

Broadly considered, it is inconceivable that we should have these numerous, thin exposures of limestones, undoubted sediments, over so wide an area, without corresponding and very much greater amounts of clastics. The comparatively few recognizable quartzites serve to corroborate the inference so far as they go, but it is still an inevitable conclusion that we must have the representatives of very much greater deposits, that have been shales or some similar materials, and that are represented now by the gneisses, because schists or slates are practically unknown.

It is also significant that so far as our present information goes the recognizable, fragmental sediments are most numerous on the east, where at the same time the limestones are thinnest and most scattered. While it is well appreciated by me, that much fuller knowledge awaits us as Professor Smyth's work progresses, yet the significance of this relation cannot be entirely overlooked, and it seems justifiable to believe that if the limestones on both sides of the mountains

belong to the same geological series, the sedimentation involved more shales and sandstones on the east and more limestone on the west. To a certain degree the same relations hold good for the Trenton series to-day, its limestone being more massive on the southwest of the crystallines and more shaly on the eastern boundary. Nevertheless, for the pre-Cambrian formations, the assured, fragmental sediments are still, as emphasized above, comparatively thin and scarce, and the inferences just stated regarding the gneisses will arise. With a view of throwing light on this question a few typical sections will now be given in some detail, and in the mind of the observer or reader, the point of view should always be maintained as to whether it is possible to explain such relations by igneous contacts, or whether we must not logically refer them to a regular sedimentary succession.

TYPICAL STRATIGRAPHICAL CROSS-SECTIONS.

Catamount Mountain.—This is the most northerly of the eastern outcrops. Although the crystallines extend for miles beyond, there are no more limestones. At the foot of a steep mountain-side that looks away to the southeast and that rises from twelve to fifteen hundred feet above the valley, a ledge of limestone has been well-exposed by quarry operations. It is 20 feet thick and 150 feet long. It is a difficult matter to convince oneself of the dip and strike, but certainly the upper edge of the limestone runs along quite regularly and considered as a whole the rock seems to be a distinctly bedded mass in other rocks. The banding of the included minerals give a dip of from 45 to 60 degrees into the mountain. All exposures of rock are concealed both above and below the limestone so that its immediate associates cannot be made out, but out in the valley, in the road, a short distance to the south Cushing has noted an outcrop of a rusty friable gneiss consisting of nearly colorless monoclinic pyroxene and microperthite. With these are sillimanite, titanite, magnetite, pyrite and graphite. A band of basic hornblende plagioclase gneiss is also associated. These latter details I quote from Cushing with whom, however, I have been over the ground. In Wilmington mountain to the southeast, I have found further outcrops of graphitic rocks and of hornblendic gneisses and pyroxenic aggregates, such as are commonly associated with the limestone.

In passing up Catamount mountain above the ledge of limestone, no outcrops can be found for a distance which involves some hundreds of feet of cross-section, and then a dark gneiss appears with parallel strike and vertical dip. Under the microscope it exhibits plagioclase, green augite, less brown hornblende, garnet and magnetite, an assemblage that has strong affinities with gabbros. Near the top of the mountain this rock yields to a gneiss with abundant quartz. I forbear to attempt to interpret this poorly exposed succession at the present, merely citing it as an illustration of the relations met and of the difficulties of the problem.

The Western Spur of Whiteface.—From the northern end of Lake Placid a wild and narrow pass runs across a small divide, separating the Ausable drainage from that of the Saranac. At very nearly the crest of the water-shed and in the foot of the steep westerly spur of Whiteface mountain, a double bed of limestone has been discovered. The upper bench is 6 feet and the lower 12 with an interval of 25 feet occupied by gneisses. Up the steep slope with a somewhat flattening dip, hornblendic gneisses extend for 300 feet of section, then feldspathic gneisses for 300 feet more, until the peculiar type of anorthosite of the Whiteface massif appears. To the westward in scattered exposures hornblendic gneisses

occur, until in the second row of hills anorthosites replace them. The exposures of limestone can only be traced a short distance on the strike, say 200 yards before they are concealed, but they have all the appearance of a regularly stratified, sedimentary rock, and their contacts give no evidence of igneous metamorphism. They dip into the mountain at about 40 degrees.

The Lewis Section of Quartzite.—About one mile west of Lewis post-office a ledge of graphitic quartzite arises out of the sandy terrace and, with a dip of 25 degrees to the west, extends for quite 100 yards without a break. It then dips under a series of graphitic gneisses, which may be found a little to the south across a narrow gulch. Still further westward and after an interval that is concealed, the anorthosites appear in a hillside. To the eastward of the quartzite ledge everything is concealed by a half mile of sand and then anorthosites again appear. The quartzites and their associated, graphitic gneisses present every character of a sedimentary series and while examining them one cannot resist the conviction that one is face to face with a fragment of an ancient series of clastics. Further south the anorthosites have been found outcropping within less than 50 feet of the sedimentary rocks and with abundant evidence of contact metamorphism.

The Two Exposures in Limekiln Mountain.—In the southwestern corner of Lewis and near its line with Elizabethtown, there arises a bunch of peaks, called Limekiln Mountain on the maps of the U. S. Geological Survey. The main summit is about 3000 feet above sea level. A number of valleys and gulches separate the mountain into several knobs. A gradual, drift-covered slope rises from the valley on the east to a height of about 1400 feet above tide, and then the shoulder of the mountain ascends quite abruptly. Just in the foot of this slope a ledge of limestone 20 to 30 feet thick has been opened up for quicklime. The dip is very flat, being almost horizontal. The exposures extend perhaps 50 yards and then are concealed by soil. The rock beneath the limestone is not shown, but excellent opportunities are afforded to run the section up the hill for a considerable distance. For 50 feet across the dip gneisses appear which are shown by the microscope to contain quartz, microperthite, some plagioclase, augite, and magnetite. After a concealed interval, rocks of a gabbroic character are met, consisting of labradorite, green augite, garnet and magnetite, but with no microperthite or quartz. If now we pass across the high ridge to the westward and down into the next valley evidences of limestones not well displayed may be discovered and then a quarter of a mile further and somewhat southwest from the first locality a beautifully exposed and regularly bedded stratum, 20 feet in thickness and dipping not more than ten degrees into the mountain is revealed in old workings for quicklime. Its general strike and dip are closely parallel with the one just mentioned, on the other side of the mountain but it has this advantage, that the gneisses are well shown beneath it, and one can climb the steep ledges of gneiss above it for more than a thousand feet of cross-section. They are the same quartzose, microperthitic gneisses mentioned a moment ago. The limestone itself forms a very flat and gentle roll and then disappears under the talus in each direction. Other small rolls can be traced out in the direction of the dip, before they disappear for good. In the bottoms of brooks in this same portion of the mountain, graphitic gneisses have been met, fairly remote from the limestone, but the forest growth is so thick and the exposures so fragmentary that connected structural details cannot well be worked out.

These two separated ledges of limestone

with their flat dips and close resemblance to the familiar sections in the Paleozoic or other well-defined sediments, have borne home to the writer with greater force than have any others observed in the eastern mountains the general conception of what the ancient sediments must once have been, before metamorphism, igneous intrusions and upheavals threw them out of their simple and regular relations. They show that despite the severity of the changes elsewhere displayed, two remnants remain, not appreciably mashed, and scarcely even tilted, and one can well picture to oneself a regular and widespread sedimentary series covering extended areas in this region.

The Styles Brook Section in Southern Jay.—One more section will suffice. It is located five miles from the last and beyond a group of mountains. It runs in a northeast and southwest line across a beautiful valley, about two miles wide. In the bottom of the valley, and fortunately cleared of a heavy mantle of overlying drift by a recent freshet, about 50 feet of graphitic quarzites and gneisses with a northerly dip of 35 degrees are exposed. To the northeast, within an eighth of a mile, a huge flow of basic gabbro cuts out the sediments. To the southwest, after three-quarters of a mile of drift, there are rusty hornblendic gneisses, which dip almost the same as the previously mentioned ledge of quartzite; then after another three-quarters of a mile of drift and forest-covered mountain-side, quartzite, charged with pyrite, constitutes the country rock. Anorthosites appear not far away along the mountain, but still, despite the fragmentary exposures, one must believe in the presence of a very considerable and not greatly disturbed series of sediments. Along the strike of the first mentioned quartzite in the valley abundant limestones are found within a mile.

Instances similar to the ones which have been cited could be greatly multiplied, for we have now recorded over fifty separate exposures of the limestones in the eastern mountains, but the range of phenomena is fairly well illustrated by the above. In most cases they are isolated fragments, too much broken up by eruptives to admit of working out extended structure, but as one passes into Warren county the larger manifestations of the undoubted eruptives decrease and encouraging opportunities are afforded to trace out folds or other structural features. In one or two cases this has been done by me, and the coming summer the matter will be carried further under the auspices of the State Geologist, but more detailed work is required than we have been able to attempt in the first reconnoissance.

For the greater areas of limestone on the northwest, Smyth has found evidence of a series of compressed folds, which pitch to the northeast, and which are overturned so as to dip on both flanks to the northwest, but his statements are as yet somewhat guarded.*

The Significance of Graphite.—Graphite has been tentatively referred to in many places as one of the criteria for determining the presence of sedimentary rocks, and for a moment its value in this respect deserves consideration. While I am well aware that it often appears in pegmatitic dikes or veins, and indeed that the old historic mines at Chilson Hill, Ticonderoga are based upon deposits of this character, yet it is true that the graphite is almost never met except in close connection with the limestones or their characteristic associates, or in areas where these form a prominent feature in the local geology. The commonest occurrence is immediately in the limestones and hardly an exposure of them or of the bunches of silicates in them has been discovered without the presence of the shining black scales.

* Report of the State Geologist of New York for 1893, I., 497.

When graphite appears in metamorphic rocks it has been generally considered in America and until recently abroad as well, to have been derived from organic matter originally in the sediments, but in more recent years investigations have been carried out which throw some doubt on these conceptions. Graphite, considered purely as a mineral has come in for a large share of attention and some writers have even distinguished three varieties, viz, graphite, graphitite and graphitoid, depending on differences of physical structure or behavior with oxidizing reagents. Weinschenk, of Munich, has however quite conclusively shown in a recent paper, that all are varieties of graphite proper, differing only in fineness of scales or perfection of crystalline form. All true graphite when warmed with fuming nitric acid and potassium chlorate changes into yellow, transparent crystals, possessing the same hexagonal form as the original and exhibiting while wet and fresh, the optical properties of a negative uniaxial crystal. These are called graphitic acid. They yield by analysis somewhat variable results but they are known to have assumed over 40 per cent. of oxygen and about 1.5 of hydrogen. Other dark amorphous forms of carbon dissolve in fuming nitric acid and potassium chlorate to a brown liquid.

So far as my observations go, all the occurrences on the east are true graphite. I have not noted any other form of carbonaceous matter, but in the marbles quarried at Gouverneur there are cloudy veinings, which may not be the mineral.

In a valuable paper on the graphite deposits along the border of Bavaria and Bohemia, usually referred to as the Passau district, Weinschenk* has shown that the graphite occurs in a much decomposed gneiss, in lenticular enrichments, the best of which are associated with crystalline limestone, and all of which follow the contact line of a huge granite intrusion and at small distances from it. When the contact is left the graphite deposits become leaner and leaner and finally die out. The graphite fills all manner of cracks in the minerals of the containing rock and the interstices between the minerals and may even amount to 60 or 70 per cent. of the mass. Weinschenk concludes that the graphite has not come from original deposits in the gneiss and limestone, but from gases emitted at moderate temperatures from the granite and which penetrated into all the small cavities of the gneiss and limestone. The most probable constituents of the gases are thought to be carbonic oxide, carbonates of iron and manganese, cyanides of titanium, carbonic acid and water. All contributions from the gneiss and limestone and all other forms of carbonaceous matter are specifically ruled out.

* Weinschenk, E., 1897. Vorkomnisse aus Graphitlagerstätten nordöstlich von Passau. *Zeit. f. Kryst.* and *Min.*, 1897, XXVII., 135.

Into the abundant other literature of graphite, especially as concerns Ceylon or other productive regions, I do not go as the important point before us is to determine the significance of the graphite in the Adirondack rocks, and to decide whether its carbon has been introduced by the eruptives. Of eruptives there is no lack, if not always in immediate association with the graphitic rocks, at least within short distances.

In any conclusions the following conditions must be met:

1. The graphite is in all the crystalline limestones, sometimes richly.

2. It is most coarsely crystalline in the pegmatitic bunches of silicates, which of all sizes from that of the finest to that of many cubic yards, are so richly present in the limestones.

3. It is richly developed in the quartzite at Hague and appears in many others in less amount.

4. It forms scattered scales in the rusty gneisses which are associated with the limestones, but here only in comparatively small amount.

5. It enters richly some pegmatite veins and forms pockets of considerable size as well as leaf-like individuals which wrap around the component minerals of the rock, penetrate their cracks and impregnate every fissure. In the Ticonderoga veins, which cut across the foliation of a gneiss, the graphite is associated with feldspar, quartz, pyroxene, calcite and apatite, all in very coarsely crystalline development.

6. It also forms veins by itself in gneisses, as at Split Rock, near Essex, where fissures an inch or more wide are lined with large leaflets, growing out from the walls and mingled with quartz in small amount. To what depth the veins extend cannot be stated, but they run for some yards on the surface in the little prospect where they are exposed.

7. Graphite has been discovered by me in one place in anorthosite, where the latter was in close association with rocks of the limestone series. One or two small scales were detected in the midst of the labradorite crystals. Dr. Hillebrand of the United States Geological Survey has also determined by analysis the presence of carbon not combined as carbonates to an amount of 0.05 per cent. in the igneous, titaniferous magnetites near Lincoln Pond, Elizabethtown and has obtained traces in samples from two other mines. Gneisses were located near these intrusions but no limestones have been discovered nearer than several miles.

From the above it is evident that in the cases of the pegmatite veins and included bunches of silicates in the limestones, the carbon of the graphite has been introduced into its present situation in some migratory and penetrating form and that it has permeated the crevices of the rocks. The interesting point is whether it has probably come from the intruded magmas, or whether under the metamorphic processes of a regional character as well as of a contact nature it has been produced from carbonaceous matter originally in the sediments. Despite the occurrence of very small amounts in the igneous rocks, my own opinion from the preponderating evidence is that it has been derived from the limestones, quartzites and gneisses and has only been worked over, caused to migrate and recrystallize by the metamorphosing agents. The practical limitation of the graphite in large amount to the limestones and gneisses seems to me to favor this decision, but I am free to admit that the other view has some points in its favor. There is no question that some conditions, analogous to those which favor the production of pegmatites have been necessary to yield the coarse leaves. Aside, however, from the question of origin, abundant experience has proved the value of graphite as an indicator of sediments even if it be not derived from them, and as a sort of 'type fossil' it is most useful.

Conclusion.—In conclusion the more important points of our recent work upon the Adirondack sediments may be summarized as follows. They have been shown to be much more widely distributed than we formerly appreciated, but they are absent from a wide central area, where only massive gneisses and eruptive rocks have thus far been met. That the sediments were extensive is apparent from the evidence and from the thinness of the limestones on the east as well as their association with demonstrable quartzites, we infer that the clastics were deposited in much greater amount than has been realized. Both the nature of many gneisses and also these general considerations lead us to infer that shales or related rocks have been likewise present. On the east at least we have not yet been able to prove that the sediments

form synclines, pinched into underlying gneissoid rocks. On the contrary they seem to constitute low dipping faulted monoclines.

All the sediments are thoroughly recrystallized and metamorphosed and the associated igneous rocks are plutonic or deep-seated types. Both these facts indicate their former burial at very considerable depths, and the subsequent removal of some thousands of feet by erosion. The next later rocks, of whose geological age we are assured, are the Potsdam sandstones, which lie on the old crystallines with dips seldom if ever more than ten degrees and which are not seriously metamorphosed. The greatly metamorphosed sediments are certainly pre-Potsdam and the large tectonic relations of the Georgian strata in Vermont to the Potsdam and the crystallines preclude our considering the latter as of possible early Cambrian age. We are forced to conclude therefore that they are pre-Cambrian, and from the comparatively unmetamorphosed condition of the Cambrian beds, we infer that the pre-Cambrian strata suffered their metamorphism in pre-Cambrian time. They may be taxonomic equivalents of the Huronian, but we have no good grounds for correlation.

The evidence regarding the Cambrian as interpreted by Walcott in the Champlain valley, leads us to believe that the Cambrian sediments encroached from the eastward upon the area of the crystallines. The Georgian is only found in Vermont. The Potsdam alone appears on the western side of Lake Champlain. It was not therefore any load of Paleozoic sediments, which rendered possible the deep-seated metamorphism of the pre-Cambrian sediments and the plutonic textures of the intrusions, but a load of pre-Cambrian rocks which have since disappeared. What those rocks were is an interesting subject of speculation.

They may have been sediments, whose disappearance leaves us with a lost interval. If so there is a gap in the records, which would be more comprehensible if we had better evidence of tight folds in our pre-Cambrian sediments and not the comparatively flat beds of limestone so often seen.

They may have been fragmental ejectments and vast surface flows of lava from centers of eruption whose deep-seated roots alone remain to us in the anorthosites, gabbros and syenitic rocks and whose materials piled up in the not unreasonable thicknesses of some thousands of feet, have been in time removed to contribute to the Cambrian or still earlier but undiscovered strata. Certainly the period of erosion was long and the results pronounced.

Bearing these consideration in mind, sometimes while seated upon a lofty peak of the mountains and while reflecting on the scene spread out in every direction, I have allowed my fancy free play and have pictured again the cones and vents that probably made of the Adirondacks a volcanic center comparable with Lake Superior. Beginning with eruptions of medium composition, as we know from the oldest igneous rocks now present they passed to more acidic types and closed with the basic gabbros. The fires seem then to have cooled and long erosion ensued.

Meantime beneath the piles of igneous rock, metamorphism from the hot intrusions and from the general rise of the isogeotherms went steadily forward, and the ancient sediments, whether calcareous or clastic, were changed over to marbles, quartzites and gneisses. Their carbonaceous matter became destructively distilled and penetrated every available crevice. In time it was changed to graphite. It even wandered over to the neighboring, partly cooled, igneous rocks and took part in the formation of the pegmatites.

Gradually the early Cambrian sea crept

up on the flanks, first attacking them in Vermont. The Ordovician sea followed and its sediments reached points well into the crystalline area. Pursuing the thought further we may raise the query, were the crystallines then reduced to a base-level and did submergence gradually bury them, and did the Ordovician sea and the subsequent Silurian sea go all across from side to side with a continuous mantle of sediments? Or were the crystallines a great island during all this time and have they remained so with minor faultings and upheavals to the present? These are questions easy to ask and difficult to answer. The most that we shall say about them now is that they are another story.

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ON KATHODE RAYS AND SOME RELATED PHENOMENA.

II.

THE view here briefly formulated, although first suggested by Wiechert, owes its development chiefly to J. J. Thomson. The number of instances in which its consequences are at least qualitatively confirmed is already surprisingly large. Thus it has been known for some time that a wire or carbon filament, when heated to incandescence in vacuo, sends off negatively charged particles. Thomson * has recently shown that the ratio e/m for such particles is the same as for the kathode rays. Many metals also are capable of giving off negatively charged particles when illuminated by ultra-violet light; at sufficiently high vacua, rays may be produced in this way which possess all the essential properties of the ordinary kathode rays.† In this case also, the ratio e/m is found to be the same.‡ In these cases we have an indication that the corpuscles may be separated from the molecules of a substance by processes different from those which occur at the kathode. That intense heat, on account of the violent collisions between molecules, should make it easier for the corpuscles to escape, is quite natural. And that the rapid electrical vibrations set up by light, especially by that of short wave-lengths, should produce a similar effect, agrees equally well with the corpuscular hypothesis.

* *Phil. Mag.*, 48, p. 547, 1899.

† Merritt and Stewart, *Physikalische Zeitsch.*, 1, p. 338, 1900.

‡ Thomson, *Phil. Mag.*, 48, p. 547, 1899.

If the light radiated by a molecule of gas is due to the vibration or orbital motion of these charged corpuscles, a highly concrete and satisfactory explanation is at once obtained of the Zeeman effect. The theory has shown itself capable of accounting not only for the comparatively simple phenomena first observed, but also for the more complicated modifications of the spectral lines detected later. The ratio e/m as determined from the Zeeman effect is of the same order of magnitude as that determined from observations on the kathode rays.

Perhaps the strongest confirmation of Thomson's corpuscular hypothesis is that afforded by the recent investigations, of the Becquerel rays. In 1899 it was found that some of these rays, notably those produced by certain preparations of radium, were deflected in passing through a magnetic field.* More recently, it has been found that the rays are electrostatically deflected† and that they carry a negative charge. In fact, they behave in all respects like kathode rays. Within the last few months the ratio e/m has been determined by Becquerel‡ and found to have approximately the same value as in the case of the Zeeman effect and the kathode rays.

* Meyer and v. Schweidler, *Phys. Zeitsch.*, November 25 and December 2, 1899. Giesel, *Wied. Ann.*, 69, 834, 1899. Becquerel, *Comptes rendus*, 129, p. 996, 1899.

† Dorn, *Abhandlungen d. Naturforsch. Gesell.*, Halle, March 11, 1900.

‡ *Comptes rendus*, 130, p. 809, March 26, 1900.

It appears, therefore, that the same rapidly moving corpuscles which form the kathode rays, and which give practically the only concrete explanation of the Zeeman effect, also form one constituent at least of the Becquerel rays. In the latter case it would appear that the escape of the corpuscles is a result of violent internal disturbances among the molecules of the active substance. Such disturbances may accompany a gradual change from an unstable molecular grouping to one that is more permanent. This view removes all difficulty concerning the source of energy of these rays, a question which a few years since caused a great deal of needless annoyance.

The Becquerel rays developed by a given active substance usually consist of a mixture of rays, differing widely in their various properties. Not all of these rays are deflected by a magnet. In some instances the rays are more similar to the X-rays than to kathode rays, both as regards their behavior in a magnetic field and their other properties. In such cases it seems to me probable that X-rays are in reality present. Some of the magnetically deflectable rays, which are nothing more than kathode rays, naturally fall upon the active substance itself. There is no reason why this bombardment should not result in the development of X-rays, just as it would in the interior of a vacuum tube. That Lenard's kathode rays are able to produce X-rays even in the open air has already been shown by Des Coudres.*

The hypothesis of electrified corpuscles has been employed, in a form which does not necessarily imply the extreme smallness of the particles considered, by numerous physicists. For example, Lorentz† found it useful in discussing the electrical and optical phenomena in moving bodies: while Helmholtz* has used it in his electromagnetic theory of dispersion. An explanation of metallic conduction analogous to that of electrolytic conduction has often been sought. Recently this subject has been developed quite extensively by Riecke† whose results appear extremely promising. The assumption of positive and negative ions, different perhaps from those of ordinary electrolysis, permits a very concrete qualitative explanation of a great number of well-known phenomena. Among these may be mentioned the various thermoelectric phenomena, the Hall effect, together with its thermal analogue, and the Thomson effect. Views similar to those developed by Riecke have recently been supported by J. J. Thomson.‡

Enough has been said to show that the hypothesis of electrified corpuscles has much in its favor. That the present form of the hypothesis is very incomplete and leaves much to be explained, no one would attempt to deny. But by means of it we have obtained provisional explanations, at least, of many complex phenomena; while the usefulness of the hypothesis as an aid to further investigation has already been amply demonstrated. Now that we recognize the futility of attempting an ultimate explanation of natural phenomena, can we demand more than this of any theory or hypothesis? Let us therefore adopt the new theory in those cases where its adoption leads to clearness and concreteness, and make use of it as long as it aids in the advancement of science. As our knowledge increases, the theory will be continually modified and improved. Sooner or later it will doubtless be found insufficient, and will be abandoned; and something better

* *Wied. Ann.*, 62, p. 134, 1897.

† Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern. Leiden, 1895.

* *Wied. Ann.*, 48, p. 389, 1893.

† *Wied. Ann.*, 66, p. 353 and 545, 1898.

‡ *Nature*, May 10, 1900.

will take its place. Such is, and such ought to be, the life history of all scientific theory.

The more promising a new theory appears, the more is it deserving of a careful and critical scrutiny, both from its adherents and from its opponents. The hypothesis of electrified corpuscles, which is involved in the modified Crookes theory, has proved its right to a hearing. It now has a right to demand the severest of friendly criticism. An elaborate critical discussion of the theory would be out of place in an address of this kind, even if sufficient time for the purpose were available. I wish, however, to call attention briefly to some points in connection with the subject which I think have not previously received the attention that they deserve.

Let us compare, for example, the values of e/m determined by different observers. The discrepancies between the values obtained by Wiechert and by J. J. Thomson is not surprising, since they were the first determinations of this kind that had been made. As a preliminary test of the theory, the fact that results obtained by such widely different methods were of the same order of magnitude is eminently satisfactory. A number of new determinations have been made, however, during the past two years. Since the more recent determinations were undertaken with a full understanding of the necessary experimental precautions, we should expect a close agreement among their results. But discrepancies of considerable magnitude still remain. It appears to me that the variation in the values of e/m obtained by different observers is greater than can be accounted for by experimental errors. To bring out this point, and in the hope of getting some idea of where the cause of the discrepancy is to be sought, I have prepared the following table, which contains practically all the values of e/m that have been obtained by experiments upon the kathode rays. Some of the values obtained by other methods have also been added for comparison.

The values of e/m are arranged in groups according to the method by which they were determined. The results of the most recent experiments, and presumably, therefore, the most accurate ones, are in each case placed last.

Leaving aside the results of Schuster and Wien and the first results of Wiechert, all of which were obtained by experiments of a purely preliminary character, we see that the results obtained by different observers show a satisfactory agreement, *provided that the same method was used*. Compare, for example, the two results of Kaufmann, obtained by different modifications of the same method, with that obtained by Simon. A more satisfactory agreement could scarcely be desired. Similarly, the values obtained by Lenard agree quite well with those that were obtained by J. J. Thomson when using the same method. But the smallest value obtained by the first method is twice as great as the largest value obtained by the last method. The results obtained by the second and third methods agree fairly well with each other, and are intermediate between the two extremes just mentioned. Wiechert's later determinations, however (Method III.), are subject to a possible constant error, so that these results must be regarded as uncertain.* The third method is liable to experimental error for several reasons, notably because its results are especially likely to be influenced by the conductivity of the residual gas. The effect of this source of error, as pointed out by Thomson, would be to make the results larger than they should be. Objections might also be raised to the assumptions on which the method is based. On the whole, it appears to me that the results of the first and fourth methods are to be

* *Wied. Ann.*, 69, p. 739, 1899.

regarded as the most reliable. And yet these are the methods whose results differ most widely.

As the difference appears too great to be explained by the accidental errors of observation, it is natural to seek its explanation in the assumptions upon which the two methods are based. Both methods employ the magnetic deflection of the rays and assume the same relation between deflection and velocity. But in the method of Kaufmann and Simon it is assumed that the whole potential energy of the corpuscle when at the surface of the kathode is transformed into kinetic energy of translation; *i. e.*, retarding forces due to friction or other causes are assumed to be entirely absent. The method has been criticised on that account by Schuster.* The effect of

VALUES OF e/m FOR KATHODE RAYS.

(The results are expressed in c. g. s. electromagnetic units.)

Observer.	Date.	Remarks.	Velocity. [Velocity of Light = 1].	$e/m \div 10^6$
I. Magnetic deflection and kathode potential. $Hev = \frac{mv^2}{r}$. $\frac{1}{2}mv^2 = eV$.				
Schuster.	1890			[1.1]
Schuster.	1898	Revision of former data.		[3.6]
Wiechert.	1897		About 0.3	[Less than 40]
Kaufmann.	1897	Used different gases and kathodes. Holtz machine.		17.7
Kaufmann.	1898	Holtz machine.		18.6
Simon.	1899	Holtz machine.		18.65
II. Magnetic deflection and velocity of rays. $Hev = \frac{mv^2}{r}$. v determined by the method of Des Condres.				
Wiechert.	1897		0.1	[20 — 40]
Wiechert.	1899	Hydrogen.	0.132 — 0.167	11.9 — 14.2
III. Magnetic deflection; heat developed; charge carried. $Hev = \frac{mv^2}{r}$. $\frac{1}{2}Nmv^2 = \text{heat}$. $Ne = \text{charge}$.				
J. J. Thomson.	1897	Different gases used. Induction coil.	0.077 — 0.12	10 — 14.3
IV. Magnetic deflection and electrostatic deflection. $Hev = \frac{mv^2}{2}$. $Hev = Fe$ [Two deflecting forces balanced].				
J. J. Thomson.	1897	Several gases. Induction coil.	0.077 — 0.4	6.7 — 9.1
Wien.	1898	Lenard rays.	About 0.3	[20]
Lenard.	1898	Lenard rays. Induction coil.	0.22 — 0.27	6.32 — 6.49

e/m from Zeemann effect.	(Various observers)	10 — 30
" " Ultraviolet light discharge.	J. J. Thomson.	5.8 — 8.5
" " Edison effect.	J. J. Thomson.	7.8 — 11.3
" " Becquerel rays.	Becquerel.	About 10.

The symbols used in the formulæ have the following significance: e = charge carried by each corpuscle; m = mass of corpuscle; v = velocity; N = number of corpuscles; H = strength of magnetic field; F = strength of electric field; r = radius of curvature of the rays when deflected in a magnetic field.

* *Wied. Ann.*, 65, p. 877, 1898.

neglecting the influence of retarding forces when such are really present would be to give values of e/m that are larger than the true value. For this reason, Schuster looked upon the method as giving merely a superior limit for the ratio. The experiments of Lenard make it unlikely that retarding forces can be present after the rays have emerged from the dark space. But it appears to me that in the immediate neighborhood of the kathode their equivalent might well be present. Before the electrified corpuscles can yield to the repulsion of the kathode and fly off to form the kathode rays, they must be torn loose from the molecules of which they form a part. Is it not possible that an appreciable fraction of the whole potential energy is expended in effecting this separation? Again, although it is certain that the kathode rays start from points very close to the kathode, have we any reason to suppose that they originate *exactly* at the surface? If the rays start a little in front of the kathode, the effect is the same, so far as the results obtained by Schuster's method are concerned, as if the corpuscles were subjected to retarding forces.

The most serious reason for doubting the correctness of the values obtained for e/m arises from the almost incredible velocity of the kathode rays. What right have we to suppose that ordinary electrical and mechanical laws are applicable to a particle moving at one-third the velocity of light? It appears to me that we have before us the most stupendous piece of extrapolation in the whole history of physics. Let us consider briefly the assumptions that are made and their experimental basis. The chief assumptions are as follows:

(1) The force exerted upon a corpuscle when passing through a magnetic field is proportional to the speed, being equal to Hev, where H is the field strength, e the charge, and v the speed.

(2) The force exerted upon a corpuscle when passing through an electric field is the same as though the corpuscle were at rest.

The experiments of Rowland and Himstedt afford indirect experimental evidence that the law stated in (1) is true for velocities up to about 10,000 cm. per second. In computing e/m the assumption is made that the same law holds for velocities a million times greater!

So far as I am aware, the question of the force exerted upon a moving charge by a stationary electrostatic field has never been made the subject of direct experimental inquiry. Lenard,* however, has made some experiments upon the kathode rays themselves which are of the greatest importance in connection with this question. Upon passing the rays through an intense electrostatic field in a direction parallel to the lines of force, he found that the rays were either accelerated or retarded according to the direction of the field. The change in velocity was determined by measurements of the magnetic deflection and was in some cases as great as fifty per cent. The observed change was the same in amount as would be expected if the force upon the charged corpuscles was the same as though they were at rest.

The dynamics and electrodynamics of a charged body in rapid motion have been attacked from a theoretical standpoint by J. J. Thomson,† Heaviside,‡ and Schuster.§ Rowland|| has recently called attention to the fact that this is a case for the application of an extremely fundamental scientific law, namely, that of the 'conservation of knowledge.' Our real knowledge of the subject, based upon experiment, is practic-

* *Wied. Ann.*, 65, p. 504, 1898.

† Recent Researches in Electricity and Magnetism.

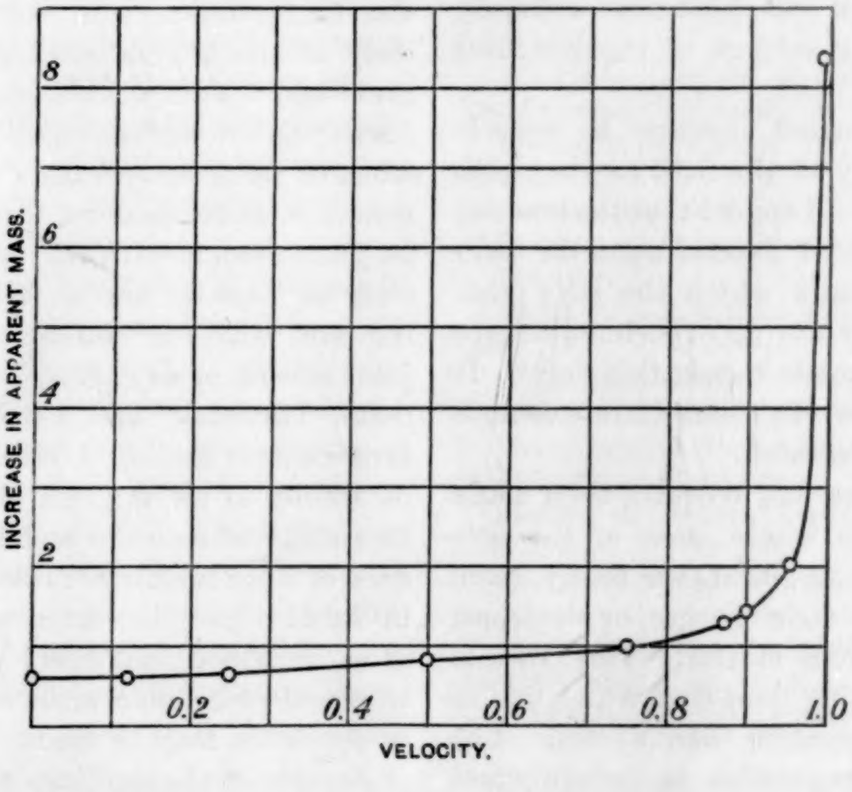
‡ Electrical Papers, Vol. 2.

§ *Phil. Mag.*, 43, p. 1, 1897.

|| Presidential Address before the American Physical Society, *Bulletin of the American Physical Society*, Vol. I., No. 1.

ally *nil:* no amount of analytical manipulation, however complicated, will add to it one iota.

In the present condition of our experimental knowledge, theoretical discussions of this nature are indeed pure speculation. But we must remember also that scientific speculation has always been one of the most important aids in the advancement of science. For a visionary enthusiast speculation is a plaything, dangerous to himself and annoying to others. But in the hands of the trained and conservative scientist it is a valuable tool, without whose aid the progress of knowledge would be slow indeed. The present case is one to whose study scientific speculation is particularly applicable. The motion of charged bodies at a speed nearly equal to that of light is a subject that we cannot hope to study by direct experiment. If we ever get a knowledge of the laws that apply in such cases, it must be by indirect methods. It is therefore simply a question of trying one hypothesis after another, deriving the consequences of each, and testing the conclusions by experiment. The kathode rays and the Becquerel rays offer the means by which such tests may be applied.



Although the theoretical results of Thomson and Heaviside are not in complete agreement, they both indicate considerable deviations from simple laws when the speed approaches that of light. Thomson states his results in convenient form by saying that the effect of a charge is to increase the apparent mass of the moving body. So long as the speed is small, the increase is inappreciable. But at high speeds it becomes important, and at the velocity of light the apparent mass becomes infinite. Since the effective mass is a function of the speed, we might therefore expect the ratio e/m to vary with the velocity of the kathode rays. But the hope of explaining the observed discrepancies in this way is illusory, as the apparent mass remains practically constant until the speed is nearly equal to that of light. The manner in which the apparent mass varies

with the speed, as computed according to Thomson's theory, is shown in the accompanying curve. Ordinates represent the apparent increase in mass, while abscissæ give the corresponding speeds. The speed of light is put equal to unity. It will be noticed that the ordinates remain nearly constant up to a speed of about eight-tenths that of light, after which the variation is rapid. In quantitative experiments on the kathode rays the speed has never exceeded one-half that of light. Previous experiments therefore afford no opportunity of testing the theory. The problem of increasing the speed still further is certainly a most promising subject of experimental investigation.

Since the apparent increase in mass is due to the energy of the field moving with the charge, it would appear that the amount of the increase must depend upon the form of the tube through which the rays pass. So far as I am aware, no experiments have heretofore been made to test this point. It may be that the variation, if it exists, is too small to be detected.

The suggestion has recently been made that perhaps the whole mass of the corpuscle is fictitious; that we really have to do with free electric charges, or electrons, existing apart from matter. This view is even more startling than that which makes the corpuscles smaller than atoms. The novelty of the suggestion is certainly not to be regarded as a serious objection. But direct experimental evidence in favor of this view is as yet lacking. Here, too, it appears to me that a quantitative study of the kathode rays *at the greatest attainable velocities* offers the most promising means of testing the theory.

We see that in this subject, as in every branch of natural science, each step in advance suggests still more important problems for further study and aids in their solution. In the kathode rays we have gained a new weapon with which to attack the great problems of ether and matter. What results will be achieved no one can predict. But great as have been the advances during the past decade, we can scarcely doubt that the progress during the decade that is just beginning will be even greater.

Ernest Merritt.

Cornell University.

MATHEMATICS AND ASTRONOMY AT THE AMERICAN ASSOCIATION.

The meeting of Section A was arranged with a view to complete co-operation with the Astronomical and Astrophysical Society in the astronomical part of the program and with the American Mathematical Society in the mathematical part. The full effect of such co-operation was secured by means of joint sessions, Section A meeting in joint session with the Astronomical Society on Tuesday and on Wednesday morning, and with the Mathematical Society in joint session or as guests, Wednesday afternoon, Thursday, and Friday. From this arrangement Section A received the benefit of adding to its program the papers of the two affiliated societies and having the presence of their members in its meetings while in turn, it gave the same aid to them. It is to be hoped that every year in which it is practicable some such arrangement for co-operation may be made.

Reports of the meetings of the Astronomical and Astrophysical Society and the American Mathematical Society will be published separately, hence it would be out of place to here discuss any of the papers presented by them. Among the papers of Section A, that of Henry S. Pritchett, who is leaving the Superintendency of the Coast and Geodetic Survey to become President of the Massachusetts Institute of Technology, is of perhaps the widest general interest; it is on the 'Functions, Organization and future Work of the U. S. Coast Survey.'

Dr. Pritchett divided his paper into three parts.

1. What is the purpose of the Service? The principal purpose he says is to make complete surveys and charts of the coasts of the United States. Added to this is the work of geodesy and the magnetic observations on land and sea.

2. Is it properly organized to carry out this purpose?

In the original organization the work was mostly in the hands of the army and navy. There has, however, been a complete change in this and with July 1, 1900, the Survey becomes entirely civilian. Within the last three years there has been a reorganization with the idea of developing a clear line of responsibility from the head of the service to each employee and with the further purpose of dividing the work so as to secure a more direct supervision of it.

3. What lines of work should it follow to accomplish the purpose in view?

The work has been planned as follows: First, a re-survey of parts of the mainland of the United States coasts and surveys of the coasts of Porto Rico, Hawaii, the Philippines, and Alaska. Second, the completion of an arc extending along the ninety-eighth meridian from the Rio Grande to the Canadian border, and the completion of the precise level net for the United States. Third, a general magnetic survey of the country and the waters adjacent.

Another paper of great interest and importance was Dr. G. A. Miller's 'Report on Groups of an Infinite Order.' The theory of groups in mathematics is of recent development but has assumed a place of fundamental importance. It is to reports from those who have made a special study of groups that we must look for an adequate survey of the subject as it stands to-day. Section A is especially fortunate in having had three reports which are supplementary to each other, at the last three meetings; the first of these reports was given at the Boston meeting by Dr. G. A. Miller and was on 'The Modern Group Theory'; the second, 'Report on the recent Progress in the Theory of Linear Groups' was given by Professor L. E. Dickson at Columbus, and the third is the one whose title is given above.

The following is the list of papers read before Section A:

'Miss Catherine Wolf Bruce,' by Miss Mary Proctor.

'Report on the Work of the Columbia College Observatory,' by J. K. Rees.

'Variations of Latitude,' by G. A. Hill.

'The Functions, Organization and Future Work of the United States Coast and Geodetic Survey,' by H. S. Pritchett.

'The Precise Level Net of the United States and a New Levelling Instrument,' by J. F. Hayford.

'New Light on Ancient Eclipses,' by J. N. Stockwell.

'The Case Almucantor,' by C. S. Howe.

'Standards of (faint) Stellar Magnitudes,'* by E. C. Pickering.

'Variations of Brightness of Stars in *m* 3,'* by S. J. Bailey.

'On the Spectroscopic Determination of Motion in the Line of Sight,' by W. W. Campbell.

'The Velocity of Meteors from the New Haven Observations,'* by W. L. Elkin.

'Parallax of Stars with Large Proper Motions,'* by F. L. Chase.

'On the Prediction of Occultations,'* by G. W. Hough.

'The Comparative Accuracy of the Transit Circle and the Vertical Circle,' by G. A. Hill.

'The Propagation of the Tide Wave,' by T. J. J. See.

'The Dimensions and Density of Neptune,' by T. J. J. See.

'Photometric Observations of Eros,' by H. M. Parkhurst.

'Secular Variations of the Motions of the Planets,' by J. N. Stockwell.

'A New Method of Finding the La Place Coefficients in the Theory of Planetary Perturbations,' by J. N. Stockwell.

'On a Method of photographing the entire Corona, employed at Newberry, S. C., for the total Solar Eclipse, May 28, 1900,' by W. G. Levison.

'Some Remarkable Properties of Recurring Decimals,' by Edgar Frisby.

* Astronomical and Astrophysical Society paper.

'History of the Complex Number,' by G. T. Sellew.

'The Motion of a Top taking into account the Rotation of the Earth,'** by A. S. Chessin.

'Kelvin's Treatment of Instantaneous and Permanent Sources extended to certain cases in which a Source is in Motion,'** by James McMahon.

'Oscillating Satellites',** by F. R. Moulton.

'On a Mechanism for drawing Trochoidal and allied Curves,'** by F. Morley.

'On Surfaces sibi-reciprocal under those contact Transformations which transform Spheres into Spheres,'** by P. F. Smith.

'On Singular Transformations in the Real Projective Group of the Place,'** by H. B. Newson.

'Report on Groups of an Infinite Order,' by G. A. Miller.

'On the Metabelian Groups whose Invariant Operators form a Cyclical Subgroup,' by W. B. Fite.

'Definitions and Examples of Galois Fields,' by L. E. Dickson.

'Construction Problems in non-Euclidean Geometry,' by G. B. Halsted.

'The Expression of a Rational Polynomial in a Series of Bessel Functions of the *n*th Order,' by James McMahon.

'Sundry Metrical Theorems connected with a special Curve of the 4th Order,' by F. H. Loud.

'The Directive Force of Philosophy upon Mathematics,' by Miss M. E. Trueblood.

'Die Hesse'sche und die Cayley'sche Curve,' ** by Paul Gordan.

'On the Rational Quartic Curve in Space,'** by F. Morley.

'On a Special Form of Annular Surfaces,'** by Virgil Snyder.

'On Hyper-complex Number Systems,'** by H. E. Hawkes.

'Application of a Method of d'Alembert to the Proof of Sturm's Theorem of Comparison,' ** by Maxime Bôcher.

'Theorems on Imprimitive Groups,'** by H. W. Kuhn.

'A Simple Proof of the Fundamental Cauchy Goursat Theorem,** by E. H. Moore.

'On the Existence of the Green's Function for simply connected plane Regions bounded by a general Jordan Curve, and for Regions having a more general Boundary of positive Content,'** by W. F. Osgood.

'Quaternions and Spherical Trigonometry,'** by J. V. Collins.

'The Reduction of Binary Quantics to Canonical Form by Linear Transformation,'** by Miss B. E. Grow.

** American Mathematical Society paper.

'Some Remarks on Tetraedral Geometry,'** by H. E. Timerding.

Organized discussion of the question, What courses in Mathematics should be offered to the student who desires to devote one-half, one-third, or one-fourth of his undergraduate time to preparation for graduate work in Mathematics.** Opened by J. Harkness, E. H. Moore, F. Morley, W. F. Osgood and J. W. A. Young.

WENDELL M. STRONG,
Secretary.

PHYSICS AT THE AMERICAN ASSOCIATION.

IT was happily arranged this year that the Physical Society should meet with Section B, and this contributed to ensure a better attendance than was at first anticipated.

There were 29 papers presented before Section B, and 13 before the Physical Society. All but four were read.

The prominent characteristic of the papers presented was the care and thoroughness with which the experimental work forming the basis of the communications had been carried out. In this we see the influence of the German University training which so many of our physicists have received, but in addition to this there is superadded an ingenuity, and an adaptation of means to an end which is peculiarly American, and the result is a series of papers of the most admirable character.

Possibly the paper which excited most general interest was that of Professor R. W. Wood, on the 'Photography of Sound Waves.' The excellent photographs of the sound waves themselves, in practically every phase of transmission and reflection, and the kinetoscopic reproductions of their movement certainly marked an epoch in the history of the subject. A second paper 'On the application of the Schlieren method to the microscope,' illustrated a method apparently destined to be of the greatest value.

Another extremely valuable paper was that of Dr. Bedell, on 'Copper Saving in

** American Mathematical Society paper.

the Joint Transmission of Direct and Alternating Currents.' The author showed that when direct and alternating currents are sent over the same line, each behaves as if the other were not there, and that thus the same line can be used for two separate systems of transmission of energy, at the cost of a single line. This would seem to remove the last objection to the general use of the alternating current system and it is probable that the method will be extensively used.

In a paper on the 'Visible Radiation from Carbon,' Professor Nichols brought out the surprising fact that the radiation from carbons of the types used in incandescent lamp filaments is not, as has hitherto been generally assumed, of the same type as that from a perfectly black body, but that the radiation is *selective*, the radiation from that part of the spectrum between the red or the yellow being much greater than it is in the case of a black body. It thus becomes impossible to estimate the temperature of heated carbon from its radiation, but on the other hand a number of questions of the greatest interest are opened up which we may hope Professor Nichols' further researches will explain and which will result in considerable extensions to our knowledge of the subject.

In a paper by Professors Guthe and Trowbridge on the 'Coherer,' the authors find that their experiments on the properties of contacts can all be expressed by a single differential equation. A large number of facts are thus simply correlated, and a striking advance made in the theory of the subject.

Of a paper by Frank Allen on the 'Effect upon the Persistence of Vision of Exposing the Eye to Light of Various Wave Lengths,' in which a method suggested by Professor Nichols was used, it can only be said that it is one of those papers in regard to which, notwithstanding the apparent absence of all flaws in the admirable experimental work we are forced to reserve our opinion, since the results obtained are so utterly at variance with our preconceived ideas. No one, for example, who has done much spectro-photometry, would have anticipated that it would have been possible to obtain color curves of subjects on different days to an accuracy of less than two per cent. Again, the fact, brought out by the author's work, that an eye fatigued by yellow has its persistence altered for the red and green and not for the yellow which originally fatigued it, is apparently inconceivable.

But it is one of the fine things of science that it is perpetually impressing upon us the fact that we do not know everything yet, even in those cases where we are apt to feel that we can be most positive, so that the truly scientific man must be, at the same time very conservative, and yet capable of even greater efforts of mental gymnastics than Alice's White Queen, whom conscientious practice, in conjunction with shutting the eyes and breathing hard, had enabled to believe no less than six impossible things before breakfast. And it is quite possible that further evidence will show that we must really change our preconceived ideas in regard to color in a number of important respects. Accepting the experimental results, there would seem, as the author pointed out, no escape from the conclusion that the three fundamental color sensations are those of the red, green and violet. This is a most important result, and is to a certain extent corroborated by Mr. Ives, who in the course of a charming exposition of his three color processes during the meeting, took occasion to point out that the only screens which gave satisfactory results for such work were a red, a green and a blue-violet one.

Another very valuable paper was that by Merritt, on 'The Production of Kathode Rays by Ultra-Violet Light.' A charged disc was illuminated by ultra-violet light,

and it was shown that negatively charged particles were thrown off which possessed the properties of the cathode rays in that they were reflectible by magnetism, carried negative charges and rendered air conducting. Crookes theory of the nature of the cathode rays is thus abundantly fortified. Merritt's Vice-Presidential address was on a similar subject, and evoked great interest.

In a paper on 'A New Theory of the Electromagnetic Rotation of Light,' the writer showed that whenever light is absorbed certain phase relations between the electric and magnetic forces and fluxes in the wave are shifted in such a way as to make the plane of the wave rotate when placed in a magnetic field, and evidence was given tending to show that this is a sufficient and probable explanation of the phenomenon.

A paper by Professor F. A. Bigelow on the method of reducing barometric observation was unfortunately read by title only, as it seemed, from the abstract, to contain some very valuable suggestions and data. Two papers were read by Professor Franklin, one on 'Lecture Room Demonstrations of the Elementary Theory of Elasticity,' in which some extremely ingenious methods of illustrating such phenomena were given; the other a more abstract and mathematical paper upon 'The Flow of Energy round a Conducting Screen near a Current Sheet.' Other papers read before this section were those of Anthony, 'An Observation upon the Surface Tension of Mercury'; Knipp, 'Surface Tension of Water above 100°'; Reed, 'On Temperature Effects on a Tuning Fork' (the last two containing a large amount of very valuable experimental data). Edward Atkinson read a paper on 'The Diffusion of Light,' treating the question from the standpoint of the manufacturer's and insurance company's standpoint. As Mr. Atkinson's work has been one of the chief determining factors in the method of lighting large factories in New England and elsewhere, his remarks were of more than general interest. He brought out the interesting fact that, whilst fire losses in the days of gas had been very high, electric lighting, installed under the regulations which he and his companies had drawn up, had brought them down to almost a negligible amount. The papers, 'The Percentage Bridge and its Applications,' by H. C. Parker; 'Power Curves from Alternating Current Circuits,' by Rosa; 'Circuit Breakers and Induction Coils' and 'Experiments in Electric Lighting' by the writer, covered various forms of apparatus. Some very beautiful photographs of electrical discharges were shown by T. B. Kinraide, and though the section did not apparently agree at all with his theories, all were united in their appreciation of the results obtained and of the apparatus used in their production. Other papers which may be mentioned are those by Professor Carhart 'On the Thermodynamics of the Voltaic Cell'; C. H. Williams, 'On an Improved Lantern for Testing Color Perception'; A. D. Cole, 'On the use of the Capillary Electrometer' describing an interesting modification, much more sensitive than the usual form; and the paper by I. S. Stevens, 'On a Method for Measuring Surface Tension.' As a whole it will be seen that the standard of the papers read was of a very high order, and of more than usual interest.

It will be impossible to more than mention a few of the papers which were read before the Physical Society: Reese, 'On Zeeman Effect'; Potts, 'On Electric Absorption in Condensers'; Dorsey, 'On the Polarization of the Solar Corona'; Nichols, 'Preliminary Tests on the Efficiency of Acetylene Flame as a means of Illumination'; Tufts, 'On Some Simple Apparatus for the Study of Aërial Vibration'; Knipp, 'On the Use of the Bicycle Wheel in Illustrating the Principles of the Gyroscope';

Rosa, 'On the Measurement of Alternating Electromotive Forces of High Potentials'; Bauer, 'On the Results of Simultaneous Magnetic Observations made at various points on May 28, 1900' and Wood 'On a Mica Echelon Spectroscope Grating' are some of the titles, which show that the meeting of this Society was fully as successful as that of Section B. Dr. Bauer's paper brought out the very interesting fact that at the time of the recent solar eclipse there was a distinct variation in the magnetic elements at a number of points on or near the line of totality, and that the change was not simultaneous, but depended upon the time of totality.

To sum up, it may safely be said that the admirable papers and admirable surroundings made the present meeting of the Section B one of the most enjoyable of recent years.

R. A. FESSENDEN,
Secretary.

SCIENTIFIC BOOKS.

The Cell in Development and Inheritance. By EDMUND B. WILSON. Columbia University Biological Series, Vol. IV. Second Edition. Revised and Enlarged. New York and London, The Macmillan Co. 1900. Pp. xxi + 483, with 194 figures in the text. Price, $3.50.

The appearance of the second edition of this already famous work gives occasion for calling attention not only to the changes which it has undergone, as contrasted with the first edition, but also to its general plan and character.

At the present time the greatest problems of biology are those which center in the life of the animal and plant cell. Assimilation, growth, metabolism, reproduction, inheritance, development and even evolution are subjects upon which the study of the cell has thrown a flood of light. The cell theory has indeed attained a prominence in modern biological work, second only to the evolution theory. The appearance, therefore, of a general work on the cell is of more than ordinary concern, not alone to the biologist, but also to all persons interested in the fundamental problems of biology.

Professor Wilson's work on the cell, the first edition of which appeared in 1896, at once took first rank among books on cytology. It is not only a general summary of the results of cell studies, but also a most important contribution to knowledge. The author has brought together, under one point of view the very many isolated observations and frequently conflicting views of a multitude of writers. In this he has graciously and entirely avoided the old museum idea of collecting material without reference to its use; although he touches upon almost every important work of modern times bearing upon the cell, yet the book is no mere encyclopedia of facts or theories—all is treated in a critical spirit as so much material to be builded into a system. The labor involved in this sifting of literature and collation of results must have been prodigious and all workers in these lines owe Professor Wilson a debt of gratitude for the service which he has thus rendered.

The general plan and scope of the second edition of this work remain unaltered; in fact the subdivisions into chapters and sections remain almost exactly the same as in the first edition. After an introduction in which is given a brief but suggestive sketch of the cell theory and its relation to the evolution theory, there follow in successive chapters: (1) A general sketch of cell structure; (2) cell-division; (3) the germ cells; (4) fertilization of the ovum; (5) oögenesis and spermatogenesis, reduction of the chromosomes; (6) some problems of cell organization; (7) cell chemistry and cell physiology; (8) cell division and development, and finally (9) some theories of inheritance and development. The volume also contains an excellent glossary, a general literature list, and indices of authors and subjects.

The most important changes in the second edition are found in those chapters and sections which deal with the nature and functions of the centrosome. For the past ten years this has been one of the most perplexing problems of cytology. In 1887 both Van Beneden and Boveri maintained that the centrosome was an independent and permanent cell organ, and Boveri held that the most important event in the fertilization of the egg was the addition of

a centrosome to the egg cell, which before the entrance of the spermatozoon lacked a centrosome and was, therefore, incapable of division. Since then a large number of investigators have devoted attention to this subject with more or less conflicting results. In the first edition of his book on the Cell, Professor Wilson took a very positive stand in favor of the hypothesis of Van Beneden and Boveri; in the present edition he takes the much safer ground that the problem is still an open and unsolved one. As to the origin of the cleavage centrosomes he suggests (p. 230 *et passim*) that Boveri's hypothesis may still be maintained in a modified form if we assume that the sperm centrosome gives rise indirectly, through chemical stimuli, to the cleavage centrosomes.

Other important changes are found in the treatment of the structure of protoplasm, the mechanics of mitosis, and chromatic reduction, while minor alterations are found on almost every page. There are about 100 additional pages and more than 50 new figures, while several old figures have been redrawn and improved.

On the whole, the author's temper is much more cautious and judicial than in the first edition, while at the same time there is no loss of that enthusiasm which is the peculiar charm of his writing. The few erroneous statements of the first edition have been entirely rectified, and few, if any, new ones have crept in. Strange to say, however, the typographical errors have increased, though they are still few and for the most part unimportant. Too much praise cannot be given to the mechanical execution of the work. The illustrations are of the highest type of excellence; in fact it is no exaggeration to say that many of the figures are clearer and better than the originals (usually lithographs) from which they were taken.

The book mark of the Columbia Biological Series has been changed from a mitotic figure in the metaphase to one in the anaphase, which fittingly symbolizes the passing of this work from a first to a second edition. Although one of the latest books in this field, this is the first general work on cytology to pass through a second edition. May it see still other editions, telophases and yet other cycles of development, in the future!

EDWIN G. CONKLIN.
UNIVERSITY OF PENNSYLVANIA.

North American Forests and Forestry, Their Relations to the National Life of the American People. By ERNEST BRUNCKEN, Secretary of the late Wisconsin State Forestry Commission. New York and London, G. P. Putnam's Sons. 1900. Pp. vi + 266.

This work, which appeared early in the year, is a timely contribution to the much needed literature of forestry in North America. We have been so earnestly engaged in ridding the ground of the covering of trees which prevented us from 'planting corn to feed to hogs, to sell for money, to buy more land, to plant more corn, to feed more hogs,' etc., etc., that we have overlooked the fact that *a forest is often the best crop which a given area can produce.* With the disappearance of the great forest tracts we are learning the hard lesson that we have 'wasted our substance in riotous living,' and as the thoughtless prodigal of old finally 'came to himself' when he had spent all, so we are beginning to have different notions as to the value and importance of the heritage of trees which we so thoughtlessly wasted. This book is itself a result of this changed feeling. It is an attempt to treat the forest problems of the country as of such importance as to demand our most thoughtful consideration.

Some idea of the scope of the book may be obtained from the titles of a few of the chapters: The North American Forest, The Forest and Man, The Forest Industries, Destruction and Deterioration, Forestry and Government; Forestry and Taxation; Reform in Forestry Methods, Forestry as a Profession, etc. In the treatment of these topics the author discusses each with liberality, and is not given to urging his particular theory upon the reader's attention. In fact the book is very largely a calm discussion of forestry questions, and it is singularly free from long statements of the author's particular theories as to the proper solution of the problems in hand.

It should have a large sale throughout the country and should be found in every public

library. Some one ought to make the experiment of using it as a supplementary reader in the high schools.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Catalogue of the Flora of Montana and the Yellowstone National Park. By PER AXEL RYDBERG, Ph.D. New York. 1900. 8vo. Pp. xii+492.

This fine volume, which is issued as the first volume of the Memoirs of the New York Botanical Garden, appeared early in the year, bearing date of February 15, 1900. It is the result of several seasons of work done in the field by the author as collector for the United States Department of Agriculture and the New York Botanical Garden. When he came to work up these collections he found that the flora of Montana was but little known, and accordingly he availed himself of all the accessible material of previous collectors. The final result is a list of 1976 species and varieties of Pteridophyta and Spermatophyta, of which 776 are not recorded in Coulter's 'Manual of the Rocky Mountain Region,' and 163 are new to science.

The treatment of the subject is liberal, and we have here much more than the old-fashioned list which has all but disappeared from botanical literature. The nomenclature is modern, of course, and authorities and descriptions are so freely cited that no one need have any difficulty in certainly identifying all of the species and varieties included. Habitat and locality notes are given with much fullness, and in nearly every case herbarium specimens are particularly indicated by numbers, the only exception being in those cases where the species had been authoritatively reported in standard works. The selection of type, the size of page, and quality of paper all contribute to the finish of the work for which the author supplied so well wrought a text.

The work includes 42 Pteridophytae, 21 Gymnospermae, 423 Monocotyledones, and 1490 Dicotyledones. The large families are Polypodiaceae (22 species), Pinaceae (20), Gramineae (191), Cyperaceae (105), Juncaceae (23), Liliaceae (28), Orchidaceae (22), Salicaceae (29), Chenopodiaceae (50), Amaranthaceae(27), Alsinaceae (34), Ranunculaceae (71), Cruciferеae (76), Saxifragaceae (35), Rosaceae (84), Papilionaceae (122), Onagraceae (43), Umbelliferеae (41), Primulaceae (24), Polemoniaceae (39), Boraginaceae (40), Scrophulariaceae (93), Compositeae, including Ambrosiaceae and Cichoriaceae (357).

That much work is yet to be done in this region may be seen from the author's remark in the preface that "the area east of the 108th meridian on the south side of the Missouri River, and of the 112th meridian on the north side is practically unexplored botanically," in fact it appears that it is only the mountain regions that have been fairly well explored.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

The Agricultural Experiment Stations in the United States. By A. C. TRUE and V. A. CLARK. U. S. Department of Agriculture, Office of Experiment Stations, Bulletin No. 80. Pp. 636, pls. 153.

This book was prepared as a part of the exhibit of the American Agricultural Experiment Stations at the Paris Exposition. It is an exhaustive treatise on the history, work, and present status of the experiment stations in general and of the fifty-six stations individually, profusely illustrated with half-tones showing the buildings, plats, laboratories, herds, etc., of the different stations. It opens with an account of the general agricultural conditions of the United States as related to the work of the stations, dividing the country into six general regions. The part devoted to the history of the stations includes an account of the early experimental work carried on by the agricultural colleges and other institutions prior to the establishment of experiment stations supported by State appropriation. The first of these stations was located at Middletown, Conn., in 1875, and was afterwards removed to New Haven, where it continues in operation. The movement to secure Federal aid for experiment stations, resulting in the passage of the Hatch Act in 1887, and the development of the stations under the Hatch Act are reviewed. There are now fifty-six stations in operation, including those in Alaska and Hawaii, fifty-two of which receive Federal aid.

The relations of the stations to the general government through the Department of Agriculture, their equipment, and lines of work are discussed at considerable length. Some of the more important general results of the work of the stations are briefly noted under the following headings: (1) Introduction of new agricultural methods, crops, or industrtes, and the development of those already existing; (2) the removal of obstacles to agricultural industries; (3) defense of the farmer against fraud; (4) aid to the passage or administration of laws for the benefit of agriculture; and (5) educational results of station work. Brief as this summary necessarily is, it brings out in a striking manner the wide range of usefulness of experiment stations to the farming community, touching nearly every phase of agricultural operation from the seeding and culture of the crop to its utilization in feeding for beef, pork, lamb or milk production, or in the arts. It points also to the great benefits which have already resulted in particular lines, as in the improvement of the dairy industry, which has been practically revolutionized, and is held by the authors to be "the most important general result of experiment station work"; the maintenance of soil fertility by the economical use of fertilizers and green manures; the introduction of new crops, as Kafir corn, rape and Manshury barley; and the prevention of the ravages of a long list of injurious insects and diseases. And finally it brings out very forcibly the influence which the stations have had in arousing widespread interest in the various forms of agricultural education—a phase of the station work which is often underestimated. This influence has been exerted through the vast amount of literature distributed by the stations in the form of bulletins and reports, which go regularly into more than half a million homes and libraries, through other writings and correspondence of the station workers, their addresses at farmers' institutes, and the intimate association of the stations with institutions for higher education. "No nation has ever attempted the free dissemination of agricultural information in so wide and thorough a way as has the United States, and it is believed that the results have justified the large expenditures which have been made for this purpose. * * * The stations are not only giving the farmer much information which will enable him to improve his practice of agriculture, but they are also leading him to a more intelligent conception of the problem with which he has to deal, and of the methods he must pursue to successfully perform his share of the work of the community and hold his rightful place in the commonwealth." As a result of the intimate associations of the stations with institutions for higher education, "the pedagogical possibilities of instruction in the science and practice of agriculture have been more clearly revealed, and the claims of agricultural science have increasingly gained the respect and attention of scientists working in other lines. There is now in this country a much keener appreciation than heretofore of the fact that the problems of agriculture furnish adequate opportunity for the exercise of the most thorough scientific attainments and the highest ability to penetrate the mysteries of nature."

The larger part of the volume is devoted of accounts of the individual stations, and of the Office of Experiment Stations at Washington, which constitutes a part of the general system. These accounts, although condensed, are quite complete, and aside from giving the history, equipment and lines of work of the station, contain many interesting notes on its more important and successful investigations, evidences of usefulness, and reference to general results which have been of greatest benefit to the agriculture of the State.

An appendix contains an account of the inspection work of the stations (fertilizers, foods and feeding stuffs, apparatus for milk testing, nursery stock, animal diseases, etc.), with the principal features of the laws under which it is carried on; the general statistics of the American stations; a list of the publications issued by them since their organization; a list of books published by experiment station workers; and a catalogue of the experiment station exhibit at the Paris Exposition.

The chief regret in connection with this book is the small edition to which it was limited, which precludes its general distribution, even among experiment station workers. It is hoped that Congress will see fit to authorize a reprint,

so that it may be distributed to those most entitled to it, and placed on sale like other government publications.

E. W. ALLEN.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for July contains the following articles:

'Energy of the Cathode Rays,' by W. G. Cady.

'Volcanic Rocks from Temiscouata Lake,' Quebec, by H. E. Gregory.

'Interpretation of Mineral Analysis: a Criticism of recent Articles on the Constitution of Tourmaline,' by S. L. Penfield.

'Studies in the Cyperaceae, No. XIII,' by T. Holm.

'Titration of Mercury by Sodium Thiosulphate,' by J. T. Norton, Jr.

'Selenium Interference Rings,' by A. C. Longden.

'Carboniferous Bowlders from India,' by B. K. Emerson.

'New Bivalve from the Connecticut River Trias,' by B. K. Emerson.

'Statement of Rock Analyses,' by H. S. Washington.

'String Alternator,' by K. Honda and S. Shimizu.

'Action of Light on Magnetism,' by J. H. Hart.

THE June number of the *Bulletin of the American Mathematical Society* contains the following articles: 'Report of the April meeting of the Society,' by the Secretary; 'Report of the April meeting of the Chicago Section,' by T. F. Holgate, Secretary of the Section; 'On the history of the extensions of the calculus,' by J. G. Hagen; Burnside's 'Theory of groups,' by G. A. Miller; Shorter notices: D'Ocagne's 'Treatise on nomography,' by F. Morley; Barton's 'Theory of equations,' by J. Maclay; Rice's 'Theory and practice of interpolation,' by E. W. Brown; Braummühl's 'History of trigonometry,' and Boyer's 'History of mathematics,' by F. Cajori; and Frischauf's 'Series in circular and spherical functions,' by W. B. Ford; 'Notes'; 'New Publications.'

The July number, concluding Vol. VI. of the *Bulletin*, contains: 'Some remarks on tetrahedral geometry,' by H. E. Timerding; 'On singular transformations in real projective groups,' by H. B. Newson; 'On groups of order 8!/2, by Ida M. Schottenfels; Lobachevsky's Geometry' (second paper), by F. S. Woods; 'Burkhart's Elliptic functions,' by J. Pierpont; 'Erratum'; 'Notes'; 'New Publications'; 'Ninth annual list of papers read before the Society and subsequently published,' 'Index.'

DISCUSSION AND CORRESPONDENCE.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

TO THE EDITOR OF SCIENCE: The following criticism has been sent to me of the last schedule published by the Royal Society for the International Catalogue:

"Take for example, paleontology, the introduction states that the zoological subdivisions are identical with those of the zoological scheme, but so hasty is the compilation that the old scheme of three years ago has been republished quite forgetful of the fact that it was long since given up and replaced by a totally different one. Had one ever classified titles by this scheme, the complete want of accord would have at once appeared. On p. 14 of the zoological scheme is a half page of misprints, which could not have been overlooked had the scheme served for experiments, 'Fauna and Flora' stands as a division of human anatomy, evidently through some carelessness of copying; topics are wanting in abundance and the same topic recurs 3 or even 4 times. Indeed in spite of all the good counsel given and the two years that have been taken, these last schemes simply swarm with errors, from fundamental ones to mere careless misprints * * *."

It hardly seems possible that this schedule, so regardless of the best principles of bibliographical work, and so illogical in its classification can receive the general support which is necessary to make it a financial success. We all welcome the idea of international co-operation as the only means out of the *impasse* of over crowded literature, but before we can combine we must have put before us a scheme which is practicable.

HENRY F. OSBORN.

THE CALLOSITIES UPON HORSES' LEGS.

TO THE EDITOR OF SCIENCE: I shall feel very much obliged to any of your readers who will furnish me with any hypotheses concerning the origin of the callosities upon the legs of horses and mules, and upon the fore-legs of

asses. The idea that they are the remnant of the inner toe is, in my opinion, untenable, chiefly because this toe has been the first to disappear in all ungulates.

LAWRENCE IRWELL.

BUFFALO, N. Y., July 15, 1900.

TRANSMISSIBILITY OF ACQUIRED CHARACTERS.

TO THE EDITOR OF SCIENCE With reference to the difficulties in the way of such heredity mentioned by Professor Sedgwick in his address printed in your issue of the 6th of this month, would not modifications induced by diet during a whole lifetime have the greatest chance of being transmitted and becoming permanent in the race? By such experiment would not the reproductive cells be equally affected with the rest? These modifications could be influential during the whole lifetime, commencing even in the embryonic and antenatal stages. Thus the influence of ancestral and homochronous heredity would be, as far as possible, obviated. To learn if such a test has ever been attempted, and for any particulars, I should be much obliged.

C. G. S.

23 UP. BEDFORD PLACE, LONDON, W. C.
June 29, 1900.

CURRENT NOTES ON METEOROLOGY.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

VOL. I. of the annual Report of the Chief of the Weather Bureau has been issued. This volume contains the monthly and annual summaries for 1898, with the customary administrative report. In the latter, special attention is given to the West Indian service of the Weather Bureau. The following points seem worthy of note. In connection with the river and flood service it is stated that "during the next two years, if sufficient funds are available for the purpose, it is proposed to prepare a comprehensive work on the entire navigable water régime, giving a complete history of all river stations, elevations above tide-water, rate of flow of water, and data for flood forecasting." The health of the men in the West Indian division is stated to have been remarkably good. "Although almost all have suffered more or less from tropical fevers, and the debilitating effects of the climate, yet the continuity of observation has been interrupted by sickness only at Santiago."

THE AURORA AUSTRALIS.

IN *Ciel et Terre* for May 16th, Arctowski publishes a short paper on his observations of the aurora australis made during the recent trip of the *Belgica*. There were in all 62 observations. The phenomenon generally appeared between 7 p. m. and 2 a. m., the maximum intensity coming most frequently between 9 and 10 p. m. The maximum frequency did not come during the months of polar night, and the intensity was manifestly greatest at the equinoxes. Arctowski finds a striking similarity in the appearance of the aurora borealis as observed by Nordenskiold on the *Vega* in 1878–79, and described by him, and the aurora australis as observed on the *Belgica* expedition.

R. DEC. WARD.

HARVARD UNIVERSITY.

NOTES ON OCEANOGRAPHY.

THE DANISH 'INGOLF' EXPEDITION.

SINCE the publication of Mohn's great work on the results of the Norwegian Atlantic Expedition, the most important contribution to our knowledge of hydrographic conditions in the North Atlantic has doubtless been Knudsen's recent memoir (The Danish Ingolf Expedition, Vol. I., Part 1, Copenhagen, 1899). Knudsen has made a substantial improvement on the Negretti-Zambra deep-sea thermometer. While salinity determinations are of first importance in establishing the relations between the waters of the Gulf Stream Drift and Arctic currents, it is interesting to note that he did not use the hydrometer except as a check, but relied exclusively on the use of the chlorine coefficient, calculating the total salts from the amount of chlorine found in each water-sample by titration. He agrees with Pettersson that this convenient method gives the most accurate results. The gas analyses are especially numerous and valuable. The content of nitrogen has been used, in connection with temperature, to distinguish polar and Gulf stream water; the degree of 'supersaturation' of the surface-water with oxygen has been found to be in pro-

portion to the abundance of diatoms and vegetable plankton in general, thus confirming the laboratory experiments of Knudsen on this subject. The 'Irminger' current of Nordenskiold has been delimited more clearly than heretofore; it follows the 'Reykjanaes Ridge,' skirts the southwest and west shore of Iceland, and then divides into two branches, one of which, turning to the southwest, completes the circuit of a large eddy that centers southwest of Iceland and is characterized by the cyclonic type of rotation. The other branch runs northward, hugging the Iceland coast, then eastward, and, north of the center of the island, dives beneath the surface. The complex stratification of the water east of this point, as well as in Denmark Sound and in Baffin's Bay, is illustrated in the memoir by a large number of sections. Pettersson reproduces some of these in his helpful discussion on recent works on this portion of the ocean (*Petermann's Mittheilungen*, pp. 1 and 25, 1900).

CURRENTS IN THE NORTH SEA.

DR. T. W. FULTON, the scientific superintendent of the Fishery Board for Scotland, has reported on the success which has attended his experiments with numerous bottle-floats to determine the currents of the North Sea. (Fifteenth Ann. Rep., Pt. III.) The circulation throughout the year seems to be that of a single great current which rounds the northern end of Scotland, turns southward, skirting the eastern coast of England to Yorkshire, and then turns eastward to the Danish shore, where it assumes a northerly trend. Part of the water enters the Skagerrack, but most of it goes to form the well-known coastal current of Southwest Norway. The explanation of this curved path is one of the problems which Dr. Fulton has set himself. The prevailing and dominant west and northwest wind cannot be the immediate motor, since it blows almost at right angles to the current with its north and south trends in British and Danish waters. Yet the wind is regarded as the indirect cause of motion. In the southeast portion of the sea there is banking of water by wind stress. Escape for the surplus water is impossible through the Strait of Dover on account of the small size of that opening, and a movement is instituted along the steeper surface gradient toward the north along the Danish shore. The remainder of the current curve is explained in largest part as the result of compensation of the movement just described. The earth's rotation may be accorded some share in turning the Gulf Stream water around the northern capes of Scotland, and in causing the clinging of the North Sea current so near to the shore as is actually the case. The influence of tidal streams is excluded by Dr. Fulton, chiefly on the ground that, on the east coast of Great Britain, the north-flowing ebb is stronger than the south-flowing flood.

THE GULF STREAM DRIFT.

DOES the Gulf Stream Drift persist on the surface at all seasons of the year through the Norwegian Sea? This question, so important to Norwegian fisheries, has, according to Hjort and Gran, been definitely settled. (Report on the Norwegian Marine Investigations, 1895–97, Bergen, 1899.) During the winter the relatively warm and dense 'Atlantic' water is partly displaced by the strengthened Arctic current which runs southeast past the east coast of Iceland, but does not reach the Shetlands. On the approach of summer the polar water retires from the surface and is not found south of Iceland. This annual periodicity in the Gulf Stream Drift is accompanied by changes of greater amplitude in time, but their laws have not yet been formulated. Detailed observations on the plankton organisms show that their occurrence has likewise a marked annual periodicity which is associated with that of the currents. Further proofs of a similar relation subsisting between the herring fisheries and current variations of periods ranging from one to several years, have recently been published by Pettersson and Ekman as one result of the international researches of 1894 and 1895 in the North Sea (Bihang till k. Svenska Vet.-Akad. Handl. 1890 Bd. 25, Afd. II, No. 1.)

HYDROGRAPHY AND FAUNAS OF SPITZBERGEN COAST WATERS.

A PRELIMINARY review of the material collected by the German Expedition to the North Polar Seas in 1898 has afforded some interesting conclusions as to the conditions of life in the

waters about Spitzbergen (see *Fauna Arctica* edited by F. Römer and F. Schaudinn, Vol. 1, Jena, 1900). On the eastern side of the island the fauna is richer, species and individuals more numerous than on the west coast; in the former tract, moreover, the fauna is markedly benthonic, in the latter planktonic. These contracts are referred to the action of currents. While Gulf Stream water occupies the sea west and north of Spitzbergen it is intimately mixed with the cold water of the polar current on the east. In this zone of mixture the stenothermic and stenohalinic organisms of the plankton are killed, and thus furnish an abundant rain of food for the bottom forms. So thickly planted were the hydroids and bryozoa that at times the heavy dredge did not penetrate to the true bottom at all, but came up full of these organisms. A table of hydrographical observations appears in the narrative of the voyage.

REGINALD A. DALY.

HARVARD UNIVERSITY.

A NEW STAR IN AQUILA.

FROM an examination of the Draper Memorial photographs, Mrs. Fleming has discovered a new star in the constellation Aquila. Its position for 1900 is R. A. $= 19^h\ 15^m\ 16^s$, Dec. $= -0° 19'.2$. It was too faint to be photographed on 96 plates taken between August 21, 1886, and November 1, 1898, although stars as faint as the thirteenth magnitude are visible on some of them. It appears on 18 photographs taken between April 21, 1899, and October 27, 1899. On April 21st it was of the seventh magnitude, and on October 27, 1899, of the tenth magnitude. Two photographs taken on July 7, and July 9, 1900, show that the star is still visible, and that its photographic magnitude is about 11.5. A photograph taken on July 3, 1899, shows that its spectrum resembled those of other new stars, while a photograph taken on October 27, 1899, shows that the spectrum resembled those of gaseous nebulæ.

On July 9, 1900, the object was observed with the 15-inch Equatorial by Professor Wendell, who estimated its magnitude as 11.5 to 12.0, and confirmed the monochromatic character of its spectrum.

E. C. PICKERING.

HARVARD COLLEGE OBSERVATORY.

THE ESTABLISHMENT OF A BUREAU OF CHEMISTRY.

THE following resolutions have been approved by Council of the American Chemical Society:

WHEREAS, the laws of the several states controlling food adulterations are largely ineffective because of the interference of interstate commerce laws, and can be made effective only through national legislation,

AND WHEREAS, by bills now pending in the Congress of the United States and particularly by bills numbered H. R. 9677 and Senate 2426, it is proposed to establish in the United States Department of Agriculture a bureau of chemistry, the director of which shall, under the direction of the secretary of agriculture, be charged with the chemical investigation of the foods produced and consumed throughout the country.

Therefore be it resolved by the Council of the American Chemical Society that the Congress of the United States be, and is hereby, urged to promptly enact into law the said bills, namely H. R. 9677, and Senate 2426, and provide adequate facilities for effective prosecution of the provisions of the said bills.

Resolved, further, that a copy of this resolution be forwarded to the president of the United States Senate; to the speaker of the House of Representatives; to the chairman of the Committees on Agriculture and on Commerce and Manufactures of the Senate of the United States; to the chairman of the Committee on Interstate Commerce of the House of Representatives; to the secretary of agriculture, who shall be charged with the enforcement of the provisions of said bills, and to the presiding officers of the various sections of the Society, urging their co-operation in the movement to secure the establishment of the bureau of chemistry, which shall be charged with the scientific and chemical work required in the enforcement of the provisions of the said bills.

SCIENTIFIC NOTES AND NEWS.

M. GIARD has been elected a member of the Paris Academy of Sciences in the section of anatomy and physiology in the room of the late Milne-Edwards. He received 30 votes, 16

being cast for M. Delage and 12 for M. Vaillant. M. Dwelshauvers-Dery has been elected a correspondent for the section of mechanics and M. Oehlert for the section of mineralogy.

THE Berlin Geographical Society has elected honorary members as follows: Mr. Alexander Agassiz, Gen. A. W. Greely, U. S. A., Mr. Morris K. Jesup, President of the American Museum of Natural History, Professor James Geikie, and Professor Bidal de la Blache of Paris. The Society has conferred the gold and silver Karl Ritter medals on Dr. V. Semenoff of St. Petersburg and Dr. Hans Steffen of Santiago, Chile, respectively, and the gold and silver Gustav Nachtigal medals on Dr. W. Bornhardt of Clausthal and Dr. Hans Meyer of Leipzig. The Georg Neumayer medal, this year awarded for the first time, was bestowed upon Dr. Boergen of Wilhelmshaven.

THE Balbi-Valier prize (3000 fr.) of the Venetian Institute of Sciences has been awarded to Professor Grassi at Rome, for his work on the relation of mosquitoes to malaria.

THE Paris Academy of Moral and Political Sciences has awarded its Audifred prize of the value of 15,000 fr. to Dr. Yersin for the discovery of his anti-plague serum.

THE Royal Society of Edinburgh has elected the following to honorary membership: Professor Dr. G. F. Fitzgerald (Dublin), Professor Andrew Russell Forsyth (Cambridge), Professor Archibald Liversidge (Sydney), Dr. T. E. Thorpe (London), Professor Dr. Arthur Auwers (Berlin), Professor Wilhelm His (Leipzig), and Professor A. von Baeyer (Munich).

PROFESSOR FREDINAND V. RICHTHOFEN has been appointed director of the new museum of oceanography at Berlin, and Dr. P. Dinse of Charlottenburg has been called to fill the position of curator.

WESTERN RESERVE UNIVERSITY has conferred the degree of LL.D. on Mr. Charles F. Brush of Cleveland.

WE take the following items from the *American Geologist:* Mr. Alexander N. Winchell of Minneapolis, who has been the last two years studying at Paris in the laboratories of Professors Lacroix and Hautefeuille, has been elected professor of zoology and mineralogy in The New Montana School of Mines, Butte, Montana, and will return in time for the opening of the School in September. Professor J. E. Wolff of Harvard University who spent the larger part of last winter studying in Germany is expected to return to America during the latter part of August. Dr. H. Foster Bain, recently assistant State geologist of Iowa, has undertaken a reconnoissance of the zinc field at Joplin, Mo., for the U. S. Geological Survey.

DR. A. L. BISHOP, of Buffalo, has been given charge of the Department of Archæology and Ethnology to which the Pan-American Exposition at Buffalo is paying special attention.

THE English astronomer Royal Mr. W. H. H. Christie gave a reception at Greenwich Observatory, on July 2d, at which the equipment of the Observatory was viewed by a number of visitors.

WE regret to record the death of Dr. John Ashhurst, Jr., until last year professor of surgery in the University of Pennsylvania, and the author of many important contributions to surgery and medicine. He died from paralysis, in Philadelphia, on July 7th, aged 61 years.

SIR ROBERT MURDOCH SMITH, major-general of the Royal Engineers, and since 1885 director of the Edinburgh Museum of Science and Art, died on July 3d, at the age of 65 years. He had been engaged with Sir Charles Newton's archæological expedition to Halicarnassus, had conducted explorations in Cyrenicia and had charge of the Persian telegraphs.

MR. GEORGE WORKMAN DICKSON, colonial engineer of British Guinea, died at sea on June 10th.

THE New York Board of Estimate and Apportionment has authorized the expenditure of $200,000 for the Botanical Garden and $150,000 for an addition to the American Museum of Natural History.

WE have already stated that the magnificent collection of jewels arranged by Mr. George F. Kunz and exhibited by Messrs. Tiffany & Co. at the Paris Exposition has been presented to the American Museum of Natural History. It is now known that the donor is Mr. J. Pierre-

pont Morgan. This collection will be incorporated with the Tiffany-Morgan collection of gems presented to the American Museum of Natural History in 1899, and which formed the Tiffany collection of gems at the 1889 Exposition. The entire collection will be placed in a hall now being prepared for it in the new wing of the museum.

MILNE EDWARDS has by his will bequeathed his library to the Paris *Jardin des Plantes* of which he was the director. It is to be sold and the proceeds to be applied toward the endowment of the chair of zoology which he held. He also leaves 20,000 fr. to the Geographical Society, of which he was president, for the establishment of a prize, and $10,000 to the *Société des amis des sciences.*

TRINITY COLLEGE library has received from Dr. G. W. Russell a complete copy of Audubon's 'Birds of America.' There are believed to be about 175 copies of the work about half of which are in America.

THE University of Barcelona has employed M. Benlliure, an eminent Spanish sculptor, to make a bust in bronze of M. de Lacaze-Duthiers in recognition of his services to zoology and his hospitality to foreigners who have worked in the marine laboratories established by him. The bust is now exhibited at the Paris Exposition and will be presented by members of the University of Barcelona to M. de Lacaze-Duthiers in the buildings of the University of Paris during the present month.

THE bronze monument in honor of Lavoisier by M. Barras will be unveiled at Paris on the 27th of the present month. The international subscription to the monument now amounts to $20,000. The monument in addition to the bronze statue of Lavoisier contains two bas-reliefs, one representing Lavoisier in his laboratory dictating to his wife, and the other Lavoisier explaining his discoveries to the Paris Academy of Sciences.

THE *British Medical Journal* states that a monument has been erected to the memory of Dr. Jean Hameau, the obscure general practitioner of the Gironde who in 1836 published a study on viruses, in which he partly anticipated the discoveries of Pasteur. The statue was unveiled recently at La Teste de Buch, where Hameau practiced. Addresses were delivered by Dr. Laude, the Mayor of Bordeaux and President of the Medical Syndicates Union of France, Professor Lannelongue of Bordeaux and others. Hameau was born in 1779, and died in 1851.

THE Conference on Malaria which the Liverpool School of Tropical Medicine had arranged to hold at the end of July, has been postponed on account of the date suggested clashing with the celebration of the Centenary of the Royal College of Surgeons of England and with other arrangements.

A NEW physiological society has been established in Vienna with Professor S. Exner as president.

The Ohio Geological Survey has been reorganized by the new State Geologist, Edward Orton, Jr., and is now as follows: Edward Orton, Jr., State Geologist, Economic Work in Cement and Clay Industries; Charles S. Prosser, Assistant Geologist, Stratigraphical and Areal Geology; John A. Bownocker, Assistant Geologist, Economic Work in Oil and Gas; Nathaniel W. Lord, Consulting Chemist, Economic Value of Ohio Coals; C. Newton Brown, Special Assistant, Uses of Portland Cement; Albert V. Bleininger, Assistant, Manufacture of Portland Cement; Ralph W. Nauss, Assistant in Chemical Laboratory. This summer Professor Orton and two assistants are fitting up apparatus for testing cements and he will spend some time in the field in Ohio and in visiting the leading cement works of other States. Professor Bownocker is studying the occurrence of oil and natural gas in eastern Ohio; and Professor Prosser is carrying on some stratigraphical field work in the Devonian and Carboniferous systems.

THE members of the Palisades Commission of the States of New York and New Jersey made a tour of inspection on July 13th. It will be remembered that these Commissioners have power to select the land along the Palisades which could be used for establishing a park and preserving the beauty of the rocks. The park must, however, not approach nearer the river than 150 feet. No funds are provided

for the purchase of the land, but the Commissioners may receive gifts and bequests.

SECRETARY HERBERT L. BRIDGMAN, of the Peary Arctic Club, left on July 12th, for Sydney, C. B., to superintend the departure, of the club steamer *Windward* for North Greenland, and if advisable, to take charge of the expedition. The *Windward* carries a full cargo of American flour, oil and sugar, Dominion coal and English pemmican, Maine lumber, New Bedford whaleboats and Mauser rifles from Santiago and will proceed as rapidly as ice and other conditions will permit to Peary's headquarters at Etah. The mail expected from the Norwegian friends of the Fram-Sverdrup expedition has not arrived, and the relief promised for the Robert Stein party landed last year, near Cape Sabine, has entirely failed to materialize. The fate of Stein and his companions depends upon the *Windward*.

Two volumes of the evidence before The British Indian Plague Commission have been issued. They contain a large amount of testimony and numerous reports on preventive inoculation, and other subjects, but the report of the Commissioners has not yet been issued.

A MEETING was held at Liverpool on June 25th under the auspices of the School of Tropical Medicine at which the following resolutions were adopted :

1. That this meeting of the Liverpool School of Tropical Medicine and others, having heard the views of the experts of the School on the conditions for Europeans of life in the tropics, are strongly of opinion that steps should be immediately taken by Her Majesty's Government to improve those conditions in every possible direction by the segregation of Europeans, improved sanitation, better water supply, clearance of bush near towns, light railways to the mountainous districts, and such other means as science may direct. 2. That the Liverpool Chamber of Commerce be requested to co-operate with the School, and to ask the Government to receive a joint deputation on the subject.

Addresses on the subject were made by Professor Robert Boyce, Major Ronald Ross and Professor Flexner.

ACCORDING to a cablegram to the daily papers, the first authoritative report on Count Zeppelin's airship was made on July 10th at a meeting of the society for the promotion of aërial navigation by experts who either shared in or watched the recent experiment. They declared that improvements in the steering apparatus were necessary, the one at present used having been thrown out of gear on one side of the balloon, rendering its proper guidance and return to the starting point impossible. The steering rods running upward from the car were too weak and became bent. The screw blades consequently did not respond properly. The air pressure motors failed, but it was difficult to say whether this was caused by a defect or by bad handling. The method of transmitting power to the screws will need great improvement to enable the airship to contend against even a light wind. During the recent ascent the wind had a velocity of three metres a second to a height of 100 metres, and against this the vessel sailed well, but at a height of from 150 to 200 metres the balloon was evidently driven before the wind. It must be remembered, however, that this was when one of the rudders was out of gear. If the speed of the screws cannot be increased the blades must be enlarged. Another defect was the continual escape of gas, necessitating constant filling of the receptacle up to the moment of starting. This defect alone will prevent the achievement of the idea of remaining in the air for eight consecutive days, as a single filling costs 10,000 Marks. It is imperative for financial as well as scientific reasons that this defect be overcome. The king and queen of Würtemburg will visit Friedrichshaven on July 12th, when a second ascent will be tried in their presence. On the result will depend whether the vessel shall be improved on its original lines or fundamental alterations be made. The problem will certainly not be abandoned even if there is another failure. Count Zeppelin is far too enthusiastic to give up his attempts. Moreover, large financial interests are at stake. Already more than 1,000,000 Marks have been spent on the machine and experiments, of which amount Count Zeppelin furnished about 500,000 Marks.

THE annual general meeting of Marine Biological Association was held in the rooms of the Royal Society on June 27th. *Nature* states that

the council reported that arrangements had been completed for the supply of sea-water, obtained from the open sea beyond the Plymouth Breakwater, for special experiments on the rearing of sea-fishes and other marine animals. Through the kindness of Mr. J. W. Woodall, the Association has had placed at its disposal a small floating laboratory, which is at present stationed at Salcombe. The periodical surveys of the physical and biological conditions prevailing at the mouth of the English Channel have been continued by Mr. Garstang at quarterly intervals for an entire year. Observations were taken at four fixed stations. They included serial temperature determinations at all depths, filtration of a definite column of water from bottom to surface with a 'vertical net,' and collections of the floating life at surface, mid-water and bottom by means of a special devised closing net. Mr. Garstang has also carried out a series of preliminary experiments on the rearing of sea-fish larvæ under different conditions, with a view to a solution of the difficulties hitherto encountered in regard to the practical work of sea-fish culture.

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FOR the eighth time, we believe, the courts have decided the Fayerweather will case in favor of the colleges. It is said that the case will still be carried to the Supreme Court of the United States. As the amount still involved is about $3,000,000 it is to be hoped that no legal technicality will prevent the money from being used as Mr. Fayerweather intended and that it will not be diverted to the distant heirs and the lawyers who are trying to get it.

A FELLOWSHIP in Greek has been endowed at Columbia University to be open to graduate students in Barnard College. The name of the donor is not made public. The fellowship will carry with it an annual stipend for the holder of $500.

THE foundation-stone of the Passmore Edwards Hall of the University of London, which is being erected on a site allocated for the purpose by the London County Council in Clare Market almost on the line of the projected new street from Holborn to the Strand, was laid on June 2d. The hall will furnish the home of the Faculty of Economics and Political Science (including commerce and industry), established by the University Commissioners, and in it will be carried on the future work of the London School of Economics and Political Science, which is practically coextensive with the new Faculty, and which has been admitted as a school of the University. Toward the expense of carrying on the work the London County Council will contribute £2500 a year, and Mr. Passmore Edwards has vested the sum of £10,000 in three trustees for the erection of the building and for carrying on the work of the School.

DR. WINTHROP E. STONE has been chosen president of Purdue University in Indiana as successor to Dr. James H. Smart, who died last spring. Dr. Stone has been vice-president of the university for several years.

DR. LEWIS G. WESTGATE has been appointed professor of geology in the Ohio Wesleyan University.

DR. JAMES M. SAFFORD, who has been professor of geology in Vanderbilt University for many years, has just retired at the age of seventy. For half a century he has been State Geologist of Tennessee.

DR. GEORGE P. DRYER, associate professor of physiology at the medical school of Johns Hopkins University, has been appointed professor of physiology in the Medical School of the University of Illinois.

DR. STEPHEN RIGGS WILLIAMS, an assistant in zoology at Harvard University and for two seasons instructor at the Cold Spring Biological Laboratory, has been appointed professor of biology and geology at Miami University, Oxford, Ohio, in place of Professor Treadwell, who has gone to Vassar College.

DR. JUSTUS W. FOLSOM, professor of natural science at Antioch College, Yellow Springs, Ohio, has been appointed instructor in entomology at the University of Illinois.

MR. WILLIAM RICHARD SORLEY, professor of moral philosophy in the University of Aberdeen, has been elected to the Knightbridge professorship of moral philosophy at Cambridge University, in the place of Professor Henry Sidgwick who has been compelled to resign owing to ill health.